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Impressions of a Year's Progress at Fort Peck Dam

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A MOMENT WITH THE PUBLISHERS

Give REASON a Break

ALL about us appear signs that the American people are enjoying their quadrennial silly season when reason is given a holiday to humor passion, prejudice and ballyhoo.

In places of public entertainment, otherwise intelligent citizens hiss the inanimate likeness of a President who happens to be a candidate for reelection. Editorials and cartoons in otherwise thoughtful journals revile another candidate because in other days leaders of his party espoused policies that now do not look so good. Even in their news pages, ordinarily scrupulous newspapers reveal an obvious taint of favoritism and prejudice. Normally philosophical commentators mix with their daily dose a measure of venom brutal in its failure even to pretend fairness. To "smear" is the vogue throughout the domain of public information and enlightenment.

Small wonder that the average man is betrayed into abdicating his status as the thinking animal and is content to run with the herd. The daily mail of this writer indicates that even so rational and realistic a lot as the readers of this journal are not immune to the bug. Happily their symptoms are very mild but none the less they are there.

Most of those who write in, even to differ with the views expressed on this page, do so with reason, fairness and courtesy. Their purpose is to attack a conclusion, question a viewpoint or challenge a statement of fact, rather than to ascribe motives, indulge a bad temper or shake a big stick. But lately there has been just enough of the latter to make the judicious grieve.

NO practical person, of course, will ignore the very practical fact that on Election Day he must choose between the candidates and platforms offered by the several parties. The party system offers certain advantages in the administration of a democracy; one of the prices we must pay for those advantages is the inability of each citizen to vote for his own precise ideas on public matters. When he comes to vote he always must compromise in some measure.

But although we must thus be regimented into parties when we vote, must we be regimented also in thought and feeling? When we compromise with our personal ideas on some party program must we so dope ourselves with partisan hop as to forget that we *are* compromising? When we decide to swing one way do all those who make another choice become rascals, dupes or nit-wits? To be a patriot *must* one be a partisan?

The political generals and corporals would have us think so. Do not blame them for that; that is their business. But when we fall for it, we but insult our own intelligence and indict our mental integrity.

It is many years since thoughtful Americans went to a national election more torn in their own minds between their personal ideas and the party lines. Multitudes are balancing their belief in the need for social and economic reform against their faith in the basic soundness of our established system; they are wondering how far we dare go toward strengthening government to conserve the general welfare without risk of weakening the incentives that have stimulated past progress. Many are gazing thoughtfully across party fences.

It is no function of this page to influence the political views of its readers. But it is strictly in character to remind so thoughtful a group of their obligation to stand apart from the partisan excitements now being brewed by political medicine-men.

DESPITE the necessity for party regimentation at the polls, all need not be lost to reason. After elections are won, abstract policies must be cast into practical measures. If the voter must compromise *at* elections, the office-holder must compromise *between* elections. Sooner or later those who stand for principle rather than party and for reason rather than prejudice will have their day: it is in that day that progress actually is achieved rather than during a campaign.

But if in that day reason is to prevail, the thoughtful core of our people dare not throw themselves meanwhile into the flood of partisan passion; rather should they speak and vote sanely and temperately according to their reasoned judgment as to how eventually we are to realize what they conceive to be the general good.

Willard Chevalier

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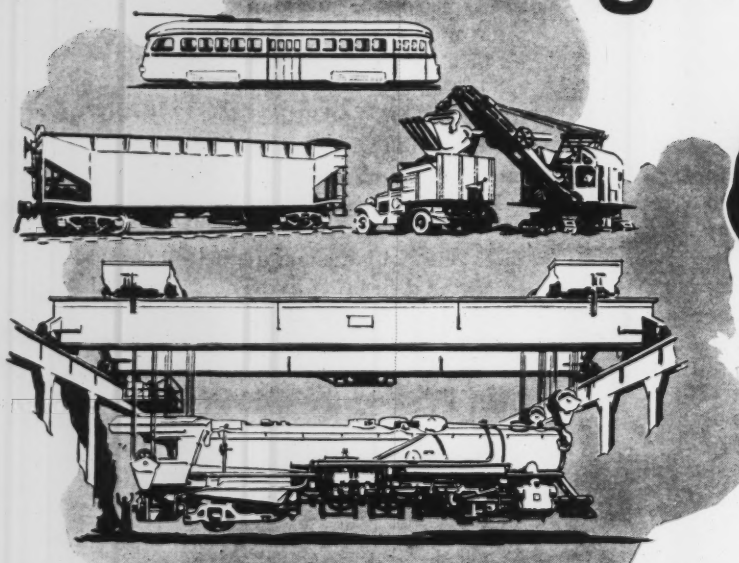
Inland Hi-Steel Solves Your Problem of Useless Weight



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Editorial Staff
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Chicago
W. W. De Berard

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■

"Men at Work"— is the sign that tells the car driver that his road is being repaired—200,000 of these men spend $350,000,000 a year in making repairs—The next issue will tell how.

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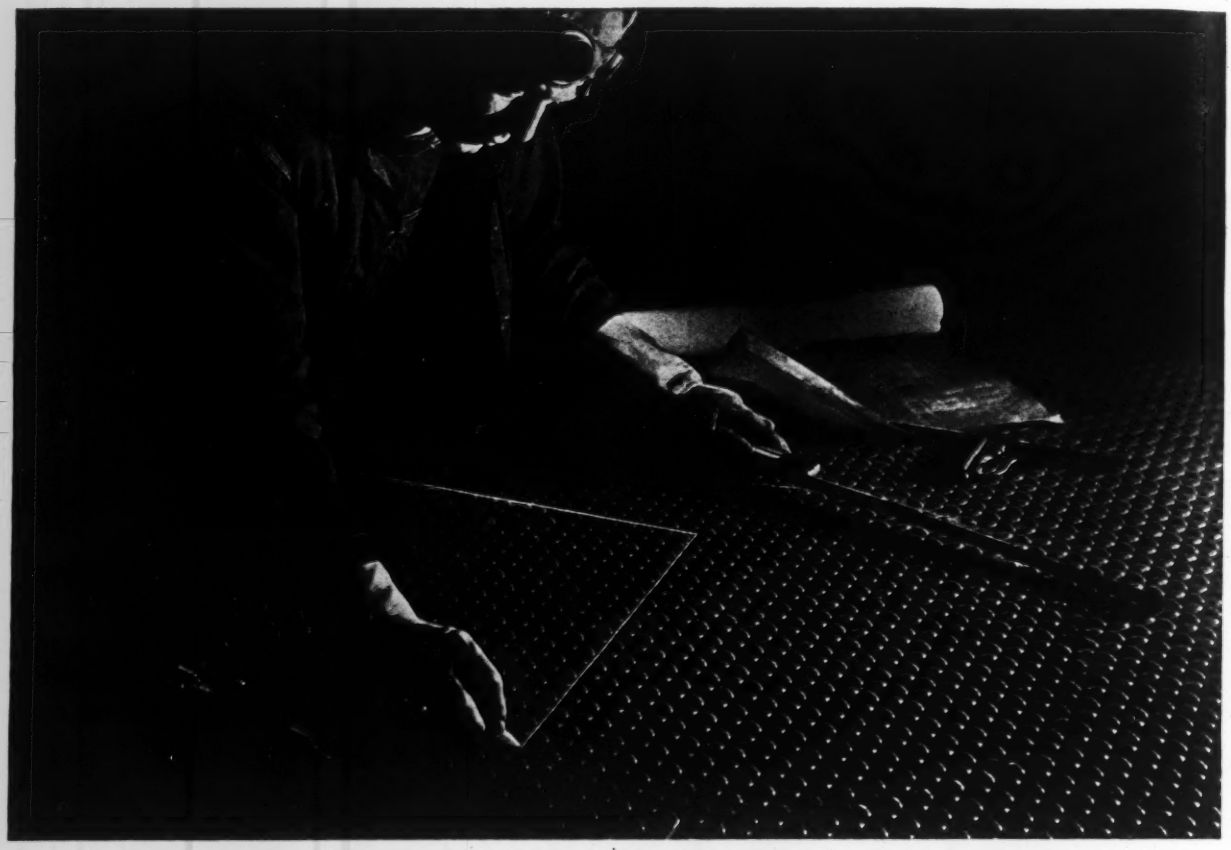

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ENGINEERING NEWS-RECORD

July 23, 1936

FORT PECK DAM today contains more than 30 million cu.yd. and is nearly one-third completed. This air view, taken from high over the east abutment, shows the river flowing through the dam, temporarily dividing the embankment into two sections. The curving arm of water beyond the far end of the dam is the core pool of the dike section. In the immediate foreground are the control shafts over the tunnels. The four dredges are working in the bends of the river at the upper left.

Fort Peck Dam Today

1—Impressions of a Year's Progress

Activities on the world's greatest earthfill dam have reached a peak this summer—Hydraulic filling on the main dam, driving of the diversion tunnels and construction of the spillway all are being pushed

By H. W. Richardson

Associate Editor, Engineering News-Record

CONSTRUCTION activity at Fort Peck Dam is at a peak this season. Ten thousand men and some seven million dollar's worth of equipment are driving the great project on the Missouri River in eastern Montana to a semblance of its completed form. A visualization of the dam, diversion tunnels and spillway in their finished state is possible today; such was not the case a year ago, when the project was swinging into its first full construction season.

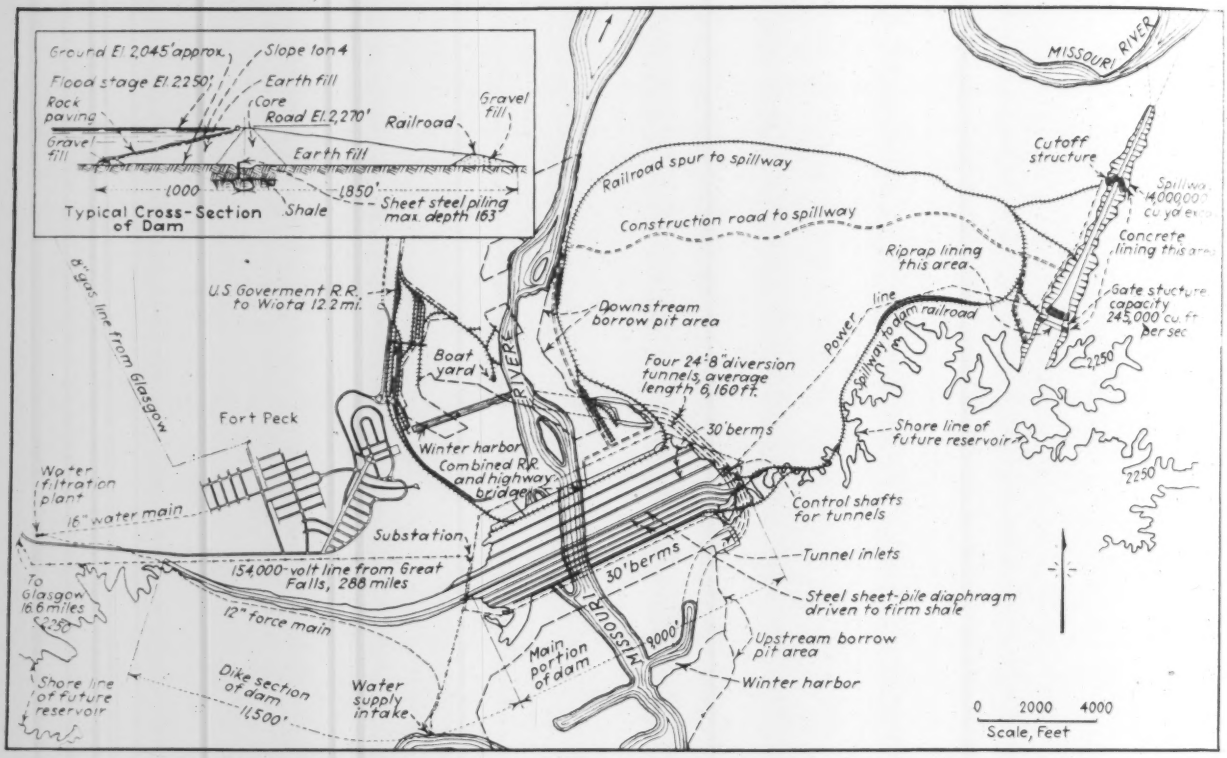
At that time, what will be by far the largest earth dam in the world was a low, far-flung fill, barely rising above the undulations of the Missouri River bottoms, split by a rib of steel sheetpile cutoff wall, and dominated by an encircling high railroad trestle. Today, the curved ends of that trestle are buried far down in the rising embankment, fill slopes tower above the remaining track, and the steel wall is embalmed deep in the silt core. The Missouri still flows unchecked along its old course between steadily rising banks, and divides the dam into two sections.

A view of the upstream borrowpit area reveals a series of rectangular lakes where once were wooded bottom lands bordering the meandering river. The lakes are mute testimony to the extent of last year's dredging operations, when some 21,000,000 cu.yd. of sand, gravel and silt were dug from the valley floor and pumped into the dam.

The greatest surprise resulting from the year's operation, however, is the sight of a long, low fill that comprises the dike section of the dam. This extends for nearly 2 miles across the prairies westward from the west abutment bluffs. The fill for this portion of the barrier was started only in mid-April of this year, and already 2,000,000 cu.yd. of material have been pumped into it from the river, 210 ft. below and a couple of miles away.

The four one-mile-long diversion tunnels piercing the shale bluffs at the east abutment of the dam are the scene of greatest activity at present. A year ago only the center pilot headings, driven complete from end to end, indicated the alignment of the huge bores to come; enlarging operations were only just getting under way. Much of the portal work was still to be done. Now the portals of massive retaining walls are about complete.

At the upper end of the tunnels, streams of shale-laden cars emerge from the pilot bores, carrying muck from top-heading enlargement operations. At the lower end, strings of lights reveal smooth concrete tubes of finished tunnel as far as the eye can see in from the portals. Steel and concrete trains enter the tunnels in endless procession, passing outbound trains of shale muck. Downstream from the portals, a muck belt conveyor extends out into the hazy distance to the stacker.



PROJECT MAP of the Fort Peck area showing the position of the principal elements, also a section of the dam.

The upstream conveyor stacker is lost from view far in a nearby coulee. A forest of guy derricks on top of the bluffs at the control shafts is evidence of continuing shaft sinking and lining operations.

Last year the two-mile gash through the hills far to the east of the dam that will serve as the spillway was a scene of apparent confusion, with a dozen shovels gouging away at 14,000,000 cu.yd. of excavation and feeding a hundred trucks speeding from shovels to dumps in clouds of their own dust. Today, comparative calm hovers over the spillway site, though it is one of the busiest parts of the project. Excavation is practically complete, except for stripping off a protective cover of shale on the floor immediately ahead of pouring the floor paving slabs. Trucks carrying buckets of concrete shuttle from mixing plant to gaping forms on the vast stretch of floor. Beyond the concrete work is the tedious process of cutting 31 miles of V-shaped slots in the shale for a network of tile underdrains. Twin mechanical saws cut the sides of the slots; a lumbering pull-shovel scoops out the core of blocky shale just ahead of a tile crew that lays the drains in a bed of gravel.

At the upper end of the spillway, the wide, smoothly-trimmed cut of last year is filled with the curving concrete gate structure and the gleaming pavement of the spillway approach. Long fingers of training walls extend downstream from the gate piers, and the special shale-boring rig used to sink 5-ft. holes for circular foundation piles is crowded into the last remaining unconcreted section. A towering central mixing plant spouts concrete incessantly as the gate structure, one of the most complicated of its kind, rises towards completion.

FEATURES OF FORT PECK DAM AND RESERVOIR

DAM

Length	20,500 ft.
Max. height	242 ft.
Max. width at base	2,875 ft.
Earth fill	100,000,000 cu.yd.
Gravel fill	4,000,000 cu.yd.
Rock fill	1,600,000 cu.yd.

RESERVOIR

Capacity	19,412,000 acre-ft.
Area	245,000 acres
Length	180 miles
Max. width	16 miles

Review of the project

The project as a whole and last year's construction operations were described in detail in the *ENR* special Fort Peck number of Aug. 29, 1935, supplemented by several articles published prior and subsequent to that time. Details of the current year's construction work will be given in articles to follow the present one in subsequent issues. However, to orient the reader a brief review of the project is given here, with an equally brief review of progress to date on the various features.

The Fort Peck Dam is being built by the U. S. Army Engineers on the Missouri River 20 miles southeast of Glasgow, Mont. It is intended primarily for regulation of streamflow for navigation. No power installation is planned at present, though one of the four diversion tunnels is being built as a penstock for possible future power use. No definite irrigation plans are included in the project.

The three main features of the project are the dam, the diversion tunnels and the spillway. Minor features include the town of Fort Peck, built solely for housing the construction forces — fully equipped with power and light, gas, water and sewer facilities; a 288-mile power transmission line; a railroad connecting with the main line of the Great Northern at Wiota, Mont., with extensions to all parts of the job; and the shops and warehouses necessary to keep contruction operations under way. Miles of roads connect the various parts of the project with the state-built hard-surfaced highway from Glasgow to Fort Peck.

There are two parts to the dam: a hydraulic-fill main dam 9,000 ft. long, 2,875 ft. wide at the base, and 242 ft. high; and a dike, decreasing in height from 55 to 5 ft., that extends for 11,500 ft. westward from the main dam. The dike is also a hydraulic fill except for the extreme end, which will be rolled in place. Dam and dike will contain 100,000,000 cu.yd. of material, making it the largest dam in the world by far, five times greater in volume than Gatun Dam at Panama, formerly the largest.

The floor of the valley at the site is alluvial fill overlying a firm shale. To

effect a watertight cutoff a steel sheetpile wall was driven down to shale the full length of the dam, some of the sheets reaching the unprecedented depth of 163 ft. The top of the sheeting extends a minimum of 20 ft. upward into the impervious silt core of the embankment.

Four diversion tunnels of 24 ft. 8 in. inside diameter, averaging over a mile long each, are being driven through the shale bluffs of the east abutment. Until these are completed (completion is now scheduled for late spring of 1937), the main dam is being built in two sections, divided by the river. Sand plugs built up on a 5:1 slope retain the ends of the silt cores next to the river. As the plugs build up, the sheetpile corewall is extended upward in the plug area only, by welding short sections of piling to those already driven, thus providing a tight diaphragm through the sand. Next year, upon diversion of the river, the center or closure section of the dam will be filled up to the level of adjacent sections and the dam will be completed in one piece.

The dam is being built by the full hydraulic method by four 28-in. hydraulic dredges. Each dredge contains two 2,500-hp. electric-drive pumps in tandem, discharging into a 28-in. pipeline. Along each of the four pipelines is a floating booster, equipped with two 28-in. pumps in tandem, and a rail mounted land booster with one pump. This year, three of the four dredges are pumping into the main dam, the fourth is building the long dike section.

Pumped material is discharged from pocket pipelines along the outside edges of the fill; the coarse material is deposited close to the lines, building up the shoulders or beaches, the finer silts are carried by the flowing sheet of discharge water across gently sloping beaches to a central core pool. Here the fines slowly settle out, forming an impervious core held in place by pervious shells. Excess water from the pool is drawn off through stepped wooden sluiceways.

Both toes of the dam are gravel fills to provide stability and drainage for the embankment. A blanket of heavy riprap will be placed on the upstream face over a mat of gravel. Bids are now being called for the furnishing of the first of the riprap stone, which must come from a distance, for there is no rock in the Fort Peck area.

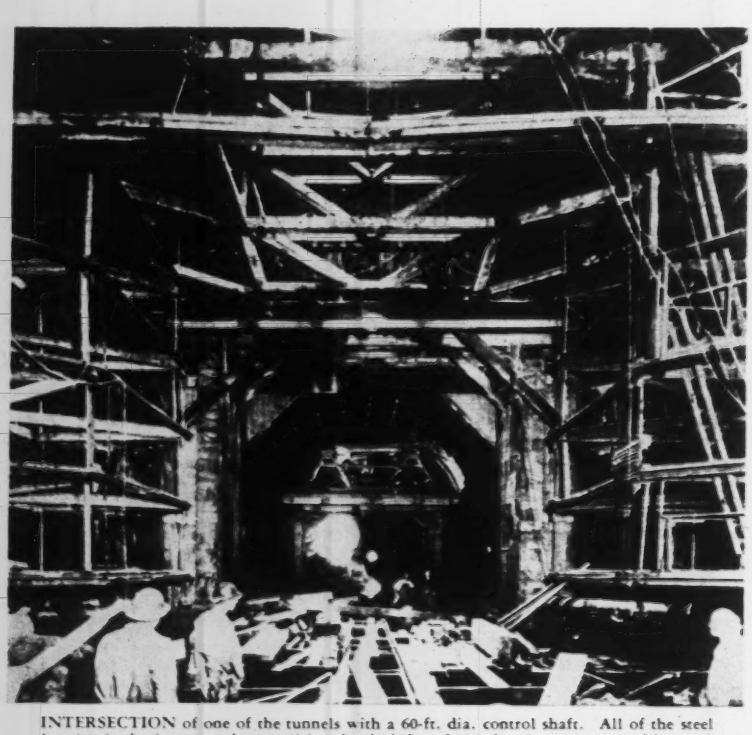
Progress in dam building

Pumping in the dam started late in 1934 with one dredge only, but was discontinued for the winter after 843,000 cu.yd. had been placed. The 1935 dredging season, Apr. 20 to Nov. 1, saw an additional 21,000,000 cu.yd. placed. Dredging operations for the current year started Apr. 16, and by June 16 a volume of 7,486,600 cu.yd. had been added to the fill. During May, 3,734,000 cu.yd. were placed, a month's record for the job so far. The total yardage in the

MORE THAN 150,000 cu.yd. of material daily is being pumped into the dam by four dredges through 28-in. discharge lines reaching strategic points of the embankment.

DREDGE JEFFERSON and her attendant plant. Alongside the dredge is a derrick boat ready to make a pump change, maneuvered by a powerful towboat. This is an unusual view of the flexible-jointed floating pipeline and the power cable that supplies current for the dredge's two 2,500-hp. pump motors.

THE TUNNELS are the busiest place on the project today, for upon their successful completion depends diversion of the river next summer. This is a view of the lower portals, where a maze of tracks carry muck, concrete and steel trains in and out of the huge bores. Tunnel No. 1, in the far corner is being equipped as a penstock.



INTERSECTION of one of the tunnels with a 60-ft. dia. control shaft. All of the steel framing in the foreground, comprising the shaft foundation bracing, was erected in small drifts and stopes from the center pilot heading while shaft excavation awaited 100 ft. overhead.

dam on June 16 was 29,228,600. Because about 17 per cent of the pumped material is lost through the pool wasteways and otherwise, actually there have been pumped into the dam a total of 35,141,260 cu.yd. of solid material.

Building of the dike started with this year's dredging, and in two months 1,861,400 cu.yd. had been pumped, of which 1,536,300 cu.yd. were retained in the fill. This 3,000,000-yd. hydraulic fill will be completed in a period of less than four months.

From a general ground level at the dam of El. 2,045, the shoulders of the west (left) bank section have been carried to El. 2,134; those of the right bank section to El. 2,118. Flow line of reservoir will be at El. 2,250, and top of dam at El. 2,270.

Tunnels

Rapid progress is being made in enlarging and lining the four diversion tunnels. On June 18 the enlarging headings in all four tunnels advanced 117 ft., or more than 29 ft. per heading in one day's work. Concrete lining keeps pace with this high speed of excavation.

The four tunnels, which total 25,213 ft. in length, curve under the east abutment of the dam, lying entirely in Bearpaw shale. This shale disintegrates very rapidly upon exposure to air. Application of a bituminous sealing solution to exposed faces checks the air slacking, and keeping the air within the tunnels at a high degree of humidity is a further aid.

Specifications required the driving of a 14x16-ft. center heading the full length of all tunnels before enlarging operations were started. These pilot tunnels were completed in the spring of 1936. At first the enlargement was carried to an excavated diameter of 32 ft. 2 in. Lining in two steps was contemplated, the first by 2 in. of concrete, the second by a steel pipe placed inside of the first lining and encased in concrete, bringing the finished diameter down to 26 ft. Early this year plans were changed to reduce the excavated diameter to 30 ft. 8 in., and the finished diameter to 24 ft. 8 in., with a single 36-in. reinforced concrete lining. The steel pipe is to be omitted except in the downstream part of tunnel 1, for possible future use as a penstock.

Control shafts

Near its midpoint each tunnel is tapped by a 50-ft. diameter (60-ft. excavation) control shaft and a 16x34-ft. emergency gate shaft, all shafts sunk about 250 ft. from the top of the bluffs. Excavation of the shafts is now complete. A massive and complicated steel structure was required as part of the shaft foundations at tunnel level. These structures, built in raises and drifts from the pilot tunnels, are now in place and concrete and steel-plate lining of the shafts is now under way.

Up to June 18 a total of 17,920 ft. of enlargement excavation had been com-

AN AIRPLANE VIEW is necessary to visualize the extent of the two-mile spillway, which cuts through the hills far to the east of the dam. In the foreground construction of the spillway gate structure is in progress. Beyond the gate preparations are under way to line the floor and sideslopes of the channel for a mile. The Missouri River can be seen at the top.

pleted. At first, ring drilling from the pilot tunnels was used for enlarging, but now a top-heading-and-bench method prevails. More than half the length of the tunnels is fully lined with concrete, a total of 13,794 ft., and an additional 1,404 ft. of invert lining is ready for the sidewalls and arch. This footage does not include additional inner lining required for three of the four tunnels to bring the early sections down to the new diameter. Enlargement operations and lining are being carried from the lower portals only, except that top-heading muck is hauled out through the upper portals by way of the pilot bores. From both portals all muck is carried to dump piles by long belt conveyors.

Spillway

Far to the east of the dam lies the spillway, a huge cut of 14,000,000 cu.yd. extending nearly 2 miles through the shale breaks of the river's right bank. To date, nearly 13,000,000 cu.yd. has been taken out of the spillway, the remainder being mostly an 8-ft. protection cover left over the floor pending placement of the concrete paving.

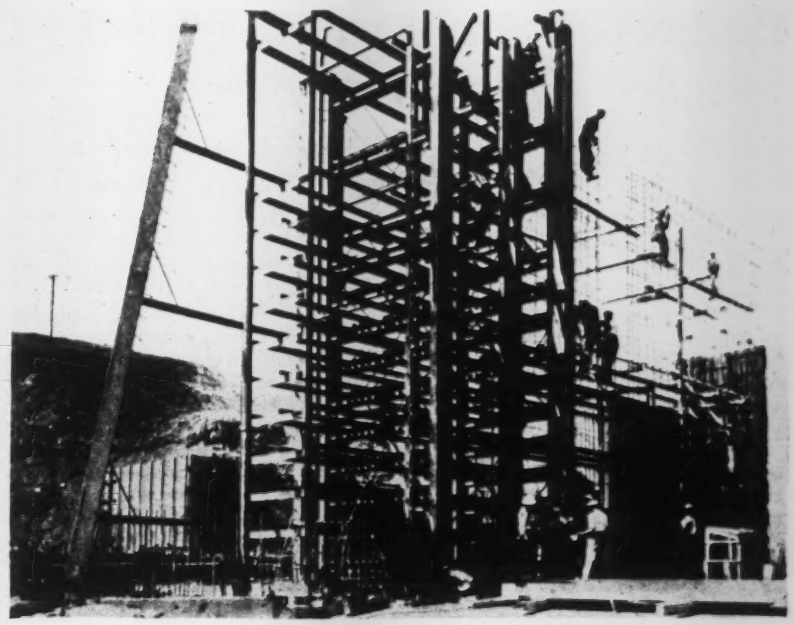
At the entrance to the spillway is a massive gate structure designed to carry sixteen 40x25-ft. Stoney gates. This structure is founded on 667 concrete cylinders 5 ft. in diameter, carried 35 to 45 ft. into the shale in holes bored by a special auger rig. Training walls extend 120 ft. downstream from the gate piers.

From a width of 800 ft. at the entrance, the spillway narrows to 130 ft. The floor and sloping walls are being paved with 28-in. minimum thickness concrete slabs for nearly a mile below the gates. A network of subdrain tile, totaling 31 mi. in length, set in V-shaped trenches, underlies the paving. At the lower end of the paved section a cellular concrete cutoff wall will be carried 130 ft. into the shale to prevent underscour.

To date, there has been poured 97,271 of the 182,340 cu.yd. of concrete required for the spillway gate piers and approaches. The last of the foundation cylinders and the massive supporting pier slabs are now being placed. A start has been made on the sloping channel approach walls. About half of the training walls are complete; steel erection on the gate supports and guides is well along.

Channel lining

From twelve to seventeen slab sections, each 20x40 ft., are being poured daily in the spillway channel below the gate structure. Stripping the protective overburden, cutting the drainage trenches in the floor with shale saws, and laying the drain tile, proceed ahead of the slab work. Pouring the floor slabs sounds like a simple operation, but this is undoubtedly the most complicated floor ever placed in a structure. One complicating item is five tons of reinforcing bars in each slab section.



STRUCTURAL STEEL for the supports and guides of the 40x25-ft. spillway gates rises above the foundation slab. Plumbing the guides under excessive changes of temperatures during the day is a problem. At the left is a sloping nose piece for a concrete pier between gates.

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It is expected that the gate structure and channel paving will be completed this season. Work will start soon on the deep cutoff wall but will probably run over into next year.

Organization

The Fort Peck project is under the direction of the Missouri River Division of the Corps of Engineers, and all planning and major designing of the job is done in the Kansas City office under the supervision of Col. R. C. Moore, division engineer. Lt.-Col. Thos. B. Larkin, district engineer of the Fort Peck District, is in direct charge of the project. The following officers of the Corps of Engineers are principal assistants to the district engineer: Major Clark Kittrell, in charge of operations; Capt. C. N. Iry, electrical power; Capt. A. W. Pence, tunnels; Capt. D. A. D. Ogden, construction of the dam; Capt. C. H. Chorpening, gravel toes and riprap; Capt. J. B. Hughes, executive assistant in charge of administration; Capt. J. R. Hardin, spillway; and Capt. E. G. Plank, land acquisition and town management.

The construction of the dam, dike and tunnels is being done by day labor under direct control of the engineer officers. The Mason & Walsh Co. formerly held a contract for the first step of the diversion tunnel construction, but this was terminated by mutual agreement last January when the plans were changed to combine the two steps into a single operation with consequent saving of one year's dredging time. The Addison-Miller Co. and Fielding & Shepley, both of St. Paul, Minn., jointly have the contract for the spillway gate and cutoff structures. The Massman Construction Co., of Kansas City, Mo., is paving the spillway channel floor and walls as part of its contract in addition to spillway excavation. Martin Wunderlich, Jefferson City, Mo., has completed his contract for the excavation of the lower end of the spillway. Sand and gravel are being supplied by contract with the J. L. Shiely Co., which has opened up an extensive sand and gravel deposit at Cole, Mont., 80 miles from Fort Peck. Coarse gravel for the toes of the dam also comes from Cole, supplied by Becker County Sand & Gravel Co. and J. L. Shiely under a joint contract.

Subsequent articles on the current year's operations at Fort Peck will deal with the dam and dike filling, the diversion tunnel enlarging and lining, tunnel grouting, construction of the spillway gate structure, and lining of channel floor and walls.

Progress in San Jacinto Tunnel Speeded by Inclined Adit

Line change, adding slightly to total length of the 13.0-mile tunnel, gives access near midpoint—Two pioneer bores started—Time saving of many months will offset delays due to water inflow

THE PROGRESS schedule all along the Colorado River aqueduct, as originally planned by the Metropolitan Water District of Southern California, is based on the expectation of completing the project and delivering water by the end of 1938. This schedule has been maintained on some 260 contracts and throughout the 300 miles of main aqueduct and distribution system except in the San Jacinto tunnel. There extremely large quantities of water under high pressures have been encountered and have delayed the work (*ENR*, Aug. 22, 1935, p. 252 and May 7, 1936, p. 661). To expedite this work and in an attempt to bring it up to schedule important changes have been made in the construction plan.

These changes provide an inclined adit (*ENR*, May 7, 1936, p. 678), about the middle of the uncompleted portion, and the use of pioneer bores between the Cabazon and Potrero headings. Excavation in the adit and in both of the pioneers now is well under way. On June 25 the inclined adit had been driven a total of 780 ft. General features of the revised program are outlined in the following.

When construction of San Jacinto tunnel first was planned consideration was given to the use of pioneer bores and also to shafts or inclined adits that would afford more points of access in the long stretch between the Potrero and Cabazon shafts. (An 8.24-mile length of the tunnel was to be driven from the two faces advanced from the bottoms of these two shafts.) Under the specifications for the tunnel as advertised, provision was made for the use of a pioneer tunnel, if such a plan was elected by the contractor. In the beginning, because of the rapid development of full face methods of excavation and the lack of complete knowledge of the underground water conditions to be encountered, the pioneer method was not selected. Because of the great depth required for any additional shaft or adit, the tunnel cost is considerably increased thereby and for that reason such access was not used originally.

However, now that delays have made the time factor of so much greater importance, expedients that will save time are necessary. An inclined adit put in from Lawrence canyon, together with the use of pioneer bores at all three points of attack, is expected to so speed up the work as to complete the tunnel from two to three years earlier than could be expected if it were driven from only the two headings. This time saving is believed to much more than offset the additional cost of these expedients.

An inclined adit was selected in preference to a shaft as the means of intermediate access because the adit could be started at a lower and therefore more accessible point. Construction utilities were readily available near the adit portal. In addition it was believed that a 5,500-ft. inclined adit could be completed in less time than would be required for sinking the 1,900-ft. shaft which would have been necessary. The cross-section of an incline could be less than that of a shaft because the latter would require two or three compartments. A combination of shaft and drift would have permitted a somewhat shallower shaft but the inclined adit would be only a little longer than the drift required with a shallower shaft. On a 25 per cent grade the slope length of the adit is 5,651 ft. and the rise is 1,300 ft. Tunnel unwatering is expected to be simpler and less expensive via the 1,300-ft. rise in the adit than by way of a 1,900-ft. shaft. Mucking and pumping are the two major problems at the inclined adit. If heavy water inflows are encountered, pumping costs easily could exceed mucking costs.

The location of the adit portal is 4½ miles south of Banning and at an elevation about 500 ft. higher. This portal is about 9,000 ft. north of the center line of the original tunnel location. The slope of 25 per cent in the adit was selected as the maximum grade on which men could work to advantage and the minimum permitted by the topography. The adit size is 10x10 ft. inside the timbering; no concrete lining is planned. By swinging the original tunnel location to the north it was possible to so locate an adit that it will intersect the newly located tunnel line about 18,000 ft. from the present face in Cabazon west heading and about 15,000 ft. from the present face in Potrero east heading. The intersection of the adit and the relocated tunnel line will be about 4,100 ft. north of the original location; this change in alignment adds only 1,028 ft. to the total length of the main tunnel.

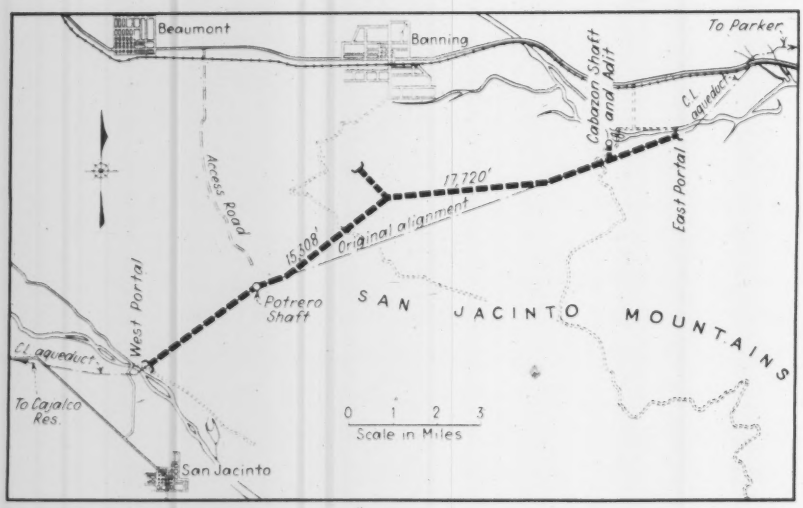


FIG. 1 — NEW ALIGNMENT of San Jacinto tunnel showing how the line was shifted to meet the inclined Lawrence adit.

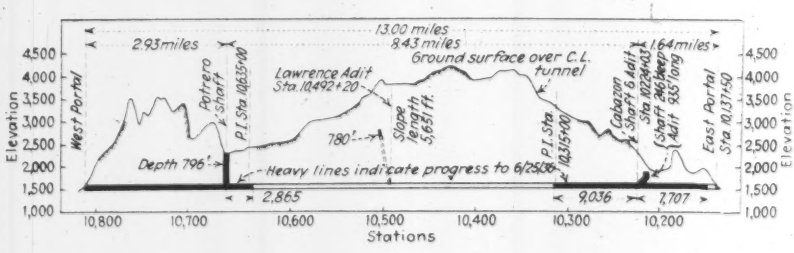


FIG. 2—PROFILE of San Jacinto tunnel showing progress to June 25 and work yet to be done.

Although the hope is for dry ground in the adit, preparations are being made for installing pumping capacity equal to that now in the Potrero pump chamber (15,000 g.p.m.). The Potrero pumping equipment will be moved to a chamber to be built to one side of the adit when the vertical depth below the surface reaches about 750 ft. By that time the pumps will no longer be needed at Potrero because concreting between Potrero and West Portal will have been completed.

The water probability in Lawrence adit is unknown. Geologists report the formation to be a particularly stable block of granite. However, plans provide for generous capacity in pumps and discharge pipes. Even though only 2,000 or 3,000 g.p.m. is encountered in the adit itself there will remain the necessity for pumping out through the adit all water encountered in drifting both ways from the bottom of the adit. At the portal of the adit provision has been made for three 18-in. water discharge lines, but only two of these will be carried down the adit until after the stationary pumps are installed. The difficulty of keeping pumps close to the heading in an inclined adit is appreciated. If pumps are bought expressly for this service a type with minimum runner clearance and maximum suction will be selected with a view to decreasing the moves as work advances.

Mucking machines

Because of the steep adit slope the ordinary mucking equipment could not be used. At the start mucking was done by hand into 1½ cu.yd. cars and progress was about 7 ft. per day. Then a slusher of the type commonly used in coal mines, but built to a heavy design developed expressly for handling heavy granite, was put in service. This slusher has a 1-cu.yd. bucket operated by a 45-hp. motor. A boom, thrust ahead of the body of the machine, has been added, consisting of a frame built up of channels welded together to form box girders. The forward end of the boom, projecting over the top of the muek pile, is rested against the face and serves as a support.

The bucket line passes through a snatch block fastened well out along the boom so that the bucket can be returned to a point well up on the muck pile. Muck is dragged up an incline and over the mucker frame to cars at the rear end. This rig has speeded up progress to as much as 18 ft. per day. So far only temporary hoisting and car arrangements are in use, but when the permanent hoist and 16-cu.yd. cars are available better performance is expected. Meantime, while the slusher is continued as a great improvement on hand mucking, endeavor is being made to provide something better suited to the requirements.

Whatever mucking equipment is used, haulage from the tunnel will be by the same means: Two 16-cu.yd. end-dump skips are on the job (one for service and a spare as standby) which will be operated by cable from a hoist. The standard-gage track in the incline emerges from the portal and continues up on a steel trestle over bunkers. A dumping mechanism operated by compressed air empties the skips into bunkers over a roadway on which a large-capacity dump truck will make the short haul of a few hundred feet from bunker to dump.

While work at Lawrence adit is being pushed, pioneer bores are being driven from Potrero east and from Cabazon west. These will parallel the main bore 75 ft. to the south, will give advance indication of formation and will make possible crosscuts to the main tunnel at intervals determined by progress. After completion of the adit and starting of the two faces from its base, two pioneer tunnels also are to be started from the adit bottom. Upon holing through, the pioneer may be used for a temporary water channel.

The Potrero pioneer will be driven upgrade on the same grade as the main tunnel. From the eastern or Cabazon end, however, because of the downgrade from that end, the pioneer will not follow the main tunnel grade but will be driven so it will drain away from the face practically all the way. To accomplish this a short section of the pioneer (usually about 100 ft.) is driven on a downgrade of about 3 per cent and then a pump sump is put in. Thereafter an upgrade of 0.13 per cent is followed until the 3-ft. drop at the start is regained. Repetition of this process will give the tunnel profile a sawtooth effect with pump intakes at each low point.

London Improves Traffic Through Crowded District

Street diversions with elevated roadways and steel and concrete bridges and viaducts eliminate grade-crossings and traffic congestion in the docks district.

SHORT BUT COSTLY road and bridge work carried out in a densely congested district of London, England, have greatly aided the heavy traffic to and from the group of three "Royal" docks and the surrounding industrial section. The following particulars of these improvements are taken from a paper presented to the British Institution of Civil Engineers by Duncan Kennedy and Hubert Edward Aldington. The cost was estimated at $12,500,000, of which the national government paid 75 per cent, while 25 per cent was distributed among several local governing bodies.

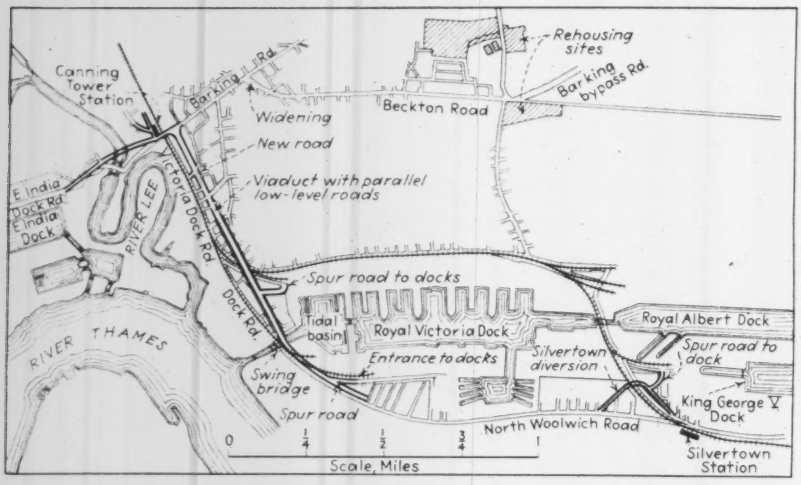
Imports and exports at the Royal Albert, Royal Victoria and King George V docks exceed 1,000,000 tons yearly, exclusive of an increasing traffic of the adjacent Silvertown manufacturing district. Owing to a bottle-neck situation all this traffic has had to use Barking Road, crossing the River Lee by a 150-ft. bridge with 35-ft. roadway, but having approaches of 4 per cent grade and sharp reverse curves. As horsedrawn vehicles form a large proportion of the traffic, these grades have been a source of continual trouble. The number of vehicles crossing the bridge in a 12-hr. day has increased from 12,995 in 1925 to 24,500 in 1935.

About 600 ft. east of the river bridge was a through-girder bridge over a railway which included a central girder that restricted traffic movements. Beyond this was a right-angle turn into the Victoria Dock Road, which had a roadway only 21 ft. wide for 2,100 ft. to a railway grade crossing over which passed all the rail traffic to and from the three docks. Lines of waiting vehicles often extended nearly 1,000 ft. from the crossing. The crossing gates were closed for more than 9 hrs. out of each 24, and during the business period they were often closed for 45 min. in each hour.

About 1,800 ft. beyond this crossing was a swing bridge over an entrance lock, and its 9-ft. roadway also carried a single-track line which was in frequent use. Thus road vehicles were again halted and formed long waiting lines. Further on was another railway grade crossing at the Silvertown station. In truck hauls having a maximum length of 4½ miles, about 35 per cent of the time was consumed in delays.

Relief from these conditions was obtained by diverting and widening the roads, providing new bridges and replacing the two grade crossings by overhead highway bridges. A housing problem was involved, as a number of dwellings of the poorer type had to be demolished, and 599 new houses first had to be built to accommodate about 3,600 occupants.

Bridges include a steel arch span of 195 ft., a three-span steel girder bridge, a concrete bowstring span of 109 ft., and concrete rigid-frame bridges of 40 to 52-ft. span. Shallow floor construction was essential in most cases. The other parts of the work are mainly reinforced-concrete viaducts. Structures are designed for a live-load of three 20-ton steam tractors hauling a 100-ton trailer on four wheels. While such loads are exceptional, requests have been



ROAD diversions and elevated roadways reduce traffic congestion at London Docks.

made for permission to haul loads of over 100 tons and up to 160 tons on four axles. Paving is mainly 2-in. asphalt, but granite blocks are used on grades over 1 per cent and wood blocks where quietness is necessary. All paving is on a 9-in. base of reinforced-concrete.

Soil and Fills—The soil consists of a surface fill underlaid by mud, peat and other material of poor bearing quality. Beneath this is 10 ft. of gravel over solid clay of unknown depth. Fills were made in 24-in. layers, compacted with 10-ton rollers. Local sandy gravel was used under the sidewalks, for convenience in laying pipes. Where it was desirable to avoid risk of internal settlement, the fill was made of 1:12 concrete, using local pit-run gravel. A special feature was that at the junction of a fill with a structure on piles, the roadway connection was a hinged reinforced-concrete slab of about 14-ft. span, on cast-iron bearings, which would thus take up any settlement of the fill.

A network of water and gas mains and electric cables and conduits had to be diverted and relaid, together with alterations to highways and to railway and street-railway lines. Thus great care had to be taken to synchronize the various operations and so minimize interference with traffic and inconvenience of the public.

River Lee Bridge—The new Barking Road bridge, 270 ft. upstream from the old one, is a two-hinged steel arch of 195-ft. span and 18-ft. rise, on a skew of 70 deg. There are 16 plate-girder ribs, with spandrel columns. Heavy concrete abutments are founded on vertical and brace piles. As a 100-ft. waterway had to be kept open for river craft, only the hinged end sections of the ribs were erected on falsework, the remaining parts being cantilevered. The two halves of each rib were erected with their outer ends above the final positions. Both halves were lowered simultaneously until their ends interlocked. With a 57-ft. roadway and sidewalks 12 and 15 ft. wide, the width between parapets is 84 ft.

Each approach consists of ten reinforced-concrete arch spans of 25 ft., with a short fill of 1:12 concrete, connected to the viaduct deck by a hinged slab of concrete of 14½-ft. span. The approach grades are about 2½ per cent. Precast concrete units were used for the parapets and the viaduct arches.

Rigid-Frame Bridge—A little beyond the river bridge, the new road crosses a four-track railway by a barrel-type concrete rigid-frame bridge of 52-ft. 8-in. clear span, with 15-ft. headroom. The foot of each abutment leg has a hinge where it rests on the footing supported by concrete piles. In this way the foundations are relieved of bending moment, enabling the number of piles to be reduced. Hinged bearings were also desirable as two 48-in. gas mains pass under the abutments, introducing complications in design of the footings.

Since falsework could not be placed for the deck, it was built in longitudinal sections, each supported from above by temporary girders resting on the abutments, which had been built in advance. The abutments were anchored to the temporary sheetpiling while in unstable equilibrium prior to completion of the deck. For the sidewalk sections, steel plate-girders were used, as gas, water and electric mains had to be carried. These girders were cased in concrete and supported by concrete abutments of the ordinary type. This bridge replaces the old structure with its central girder in the roadway.

Victoria Dock Viaduct—Barking Road was diverted and widened in connection with its two new bridges, and traffic congestion in the 21-ft. Victoria Dock Road was relieved by widening an adjacent street to 80 ft. (with 56-ft. roadway) as part of a diversion to a viaduct, ¾-mile long, which eliminates the first railway crossing. The central part of the diversion rises on the viaduct, while two side portions form parallel low-level roads which turn and pass under the structure. The approach grades are about 2½ per cent. A 60-ft. width of viaduct includes a 40-ft. (four-lane) roadway and two 10-ft. sidewalks.

The viaduct is mainly a reinforced-concrete trestle of 17½-ft. spans, with six-column bents and nine lines of girders. These columns are founded on piles cast in place. Expansion joints are formed at 55-ft. intervals. Where the height is less than 12 ft., slab and wall construction is used, the side walls being faced with precast concrete blocks. Numerous variations from the general design were necessitated by intermediate bridges at different angles of skew.

A two-span bridge crossing the railway and road approach to the south side of the Victoria Dock has spans of 50 ft. on the skew or 22 ft. on the square. Its deck is an 18-in. slab between abutments and resting on the central pier, but divided into five sections by expansion joints. The outer edges of the slab are carried by the parapet beams, which are of 50-ft. span. Of seven other bridges, crossing intersecting streets, five have skew spans of 35 ft., one has a square span of 32 ft., and one over a sidewalk is of 15½-ft. span. All have beam-and-slab decks on abutments of the ribbed type; that is, columns connected by a diaphragm or curtain wall. In the longer spans, beams rest on knuckle bearings.

The tidal channel connecting the dock with the River Thames is now crossed by a reinforced-concrete bridge of deck-girder type having a clear span of 100 ft. This avoids the use of the railway swing bridge, as only barges use this channel. The abutments are of the buttress type, with columns 30x42 in. and 9-in. connecting walls. The 15-in. deck slab is carried on eight lines of girders spaced 8 ft. 4 in. c. to c. and connected by transverse ribs. It was found possible to close the channel to navigation for a sufficient time to permit of supporting the form work on temporary piling.

A steel three-span plate-girder bridge over the railroad and two adjoining low-level roads was adopted, since it was not practicable to place falsework for concreting. The spans are 75 ft. 3 in. over the Victoria Dock Road, 73 ft. 9 in. to 81 ft. over the railroad, and 51 ft. 9 in. over the Tidal Basin Road. Each span has 11 girders 6 ft. deep. The abutments are of concrete, faced with precast concrete blocks, while the two intermediate supports consist of rows of steel columns of cruciform section, cased in concrete.

Silvertown Diversion—To eliminate the second railway grade crossing at the Silvertown Station, a loop diversion viaduct of reinforced-concrete was built, about 1,750 ft. long, with a 28-ft. roadway and two 7-ft. sidewalks. A spur leading down to the dock entrance has a 20-ft. roadway and 4½-ft. sidewalks. This viaduct is mainly of trestle type, with 20-ft. spans and 5-column bents carrying seven lines of girders. In special cases, hinges were provided at the feet of the

columns, in order to relieve them of unduly high temperature stresses and secondary stresses.

A reinforced-concrete bowstring bridge of 109-ft. clear span crosses the railroad and low-level highway. It has a roadway 28 ft. wide between curbs, and the sidewalks are carried outside the arches by cantilever extensions of the floorbeams. In each cantilever are two openings 33 in. and 18 in. in diameter for pipes and conduits, as shown in Fig. 1. The two arch ribs are square in section, with hangers of rectangular section carrying the main girders. These girders are of I-section and have cast-steel bearings on columns inside of (and independent of) the cellular abutments.

Four rigid-frame concrete bridges of 40 to 43-ft. span are included in this diversion viaduct. Two are of plain slab construction. As greater depth was permissible for the others, these are of the ribbed type, in order to economize in concrete and to reduce the dead load.

Concrete Work—Rapid-hardening cement was used for most of the reinforced-concrete, with crushed gravel and sand. Crushed granite was the aggregate in precast blocks used for pylons, wall facing, parapets and steps. A 4-in. slump test controlled the water content. Mechanical vibration was required by the specifications, and was effected by light pneumatic riveting hammers applied against the forms. Crushing strength for 6-in. cubes at 28 days (or 7 days with rapid-hardening cement) was specified as 3,600 and 2,400 lb. for 1:1½:3 and 1:2:4 mix, respectively. Actual results were tested in a crushing machine of 150 tons capacity, in a laboratory at the site.

White cement was used for the exposed faces of precast blocks and parts for parapets and pylons and for facing concrete walls. These faces were finished by rubbing with carborundum blocks. Where structural concrete was to be exposed, as in columns, it was rubbed with carborundum blocks as soon as the forms were removed, and again with the same blocks and a 1:1 mixture of cement and fine sand. On concrete with rapid-hardening cement, this treatment did not remove the skin of cement and thus entirely eliminate form marks, as the concrete was too hard for the treatment by the time the forms were removed.

For this project, the engineers were Rendel, Palmer & Tritton, with whom was associated W. Lionel Jenkins, borough engineer. Of the authors of the paper, Mr. Kennedy was connected with the firm of engineers, and Mr. Aldington was divisional road engineer (London) and engineer for the London Traffic Advisory Committee. The principal contractors were: Shanks & McEwan, for the Barking Road bridge and approaches; Dorman Long & Co. for the Victoria Dock viaduct, and Holloway Brothers for the Silvertown diversion viaduct.

An Instrument for Mounting Cross-Hairs in Telescopes

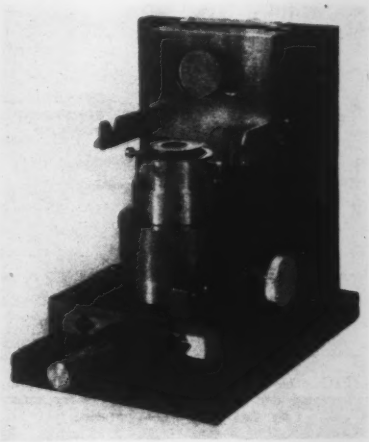
By D. L. Parkhurst
Chief, Instrument Division, United States Coast and Geodetic Survey

THE cross-hairs of telescopes for surveyor's transits and theodolites may be fine fibers of spider-web, metal or glass, from 0.0001 to 0.0003 in. in diameter, or they may be lines ruled on a glass diaphragm. A diaphragm, even though perfectly clean, obstructs the passage of light and, of course, the loss is much greater if the diaphragm is dirty. Moreover, it is not easy to rule fine and sharp straight lines on glass. Hence the U. S. Coast and Geodetic Survey seldom makes use of diaphragms, but prefers fine fibers mounted on a metal ring or reticule.

Fibers must be fine, stright, even, strong, opaque, not adversely affected by changes in temperature or humidity, and preferably elastic. Because they meet these needs better than others, fibers are used almost exclusively by the U. S. Coast and Geodetic Survey.

No matter what fiber is used, mounting it on the reticule is a most delicate job, especially when parallel wires spaced a definite distance apart are required, as in the case of a telescope used for stadia measurements. This work is usually done by hand under a magnifying glass. The fibers are stretched taut on holders shaped like a pair of draftsman's dividers, carefully placed in fine grooves ruled in the reticule by a dividing machine, and cemented in place with shellac.

An instrument to reduce this handwork to a minimum has recently been designed by the writer. The essential element of this device is a table, mounted on four steel balls running in V-shaped grooves, which may be moved horizontally. The amount of motion is measured in thousandths of an inch by a mechanic's micrometer head. A steel ball forced into the table serves as the bearing point for the micrometer.



THE RETICULE, held in the chuck, is moved to the correct position, and the cross hair lowered onto it.

The table carries a revolving turret mounted on a stock two-row ball bearing and held against too free rotation by an adjustable drag spring. Quadrant lines and a pointer permit 90-deg. setting. A chuck to hold the reticule is fastened to a standard No. 6 taper pin which fits into a hole at the top of the turret. Four screws in the rim of the chuck take care of small variations in the size of the reticule.

Fiber-supports are mounted on a slide running in dovetail ways on the upright portion of the frame and operated by an eccentric; a cup-shaped spring washer furnishes the friction to hold the slide in any position.

To use the instrument, a fiber is laid in the V's of the fiber support, and the ends of the fiber are weighted with small pellets of beeswax to furnish tension. The slide is raised to its highest position, and the reticule is placed in the chuck on the turret. The slide is lowered until the fiber is nearly in contact with the face of the reticule, and the table is moved until the fiber is in correct position. This will be the center of the reticule if cross wires only are desired. The slide is then lowered until the fiber is in contact with the reticule, and a touch of shellac is applied at the edges. When the shellac is dry, the ends of the fiber are cut off, the slide raised, and a new fiber inserted. The turret is then turned 90 deg. and the operation is repeated.

When parallel wires are required, the method is the same except that the table is moved the proper amount from fiber to fiber, the spaces being set by the micrometer.

This instrument has the advantage that all parts are held with sufficient rigidity and all motions are restrained to the desired amount and direction. There is little left to do which will require unusual dexterity on the part of the operator. The time required to mount a set of wires is materially reduced, and the operator is not subject to the excessive fatigue caused by the older method. Accuracy in spacing and parallelism of wires is easily obtained.

Soil Mechanics Notes—I

Brief summaries of important practical information extracted from selected papers presented at the International Conference on Soil Mechanics and Foundation Engineering

RAPID DEVELOPMENT of interest both in the laboratory methods and the field practices of attacking problems in soil mechanics is attested by the vast number of papers presented at the International Conference on Soil Mechanics and Foundation Engineering (*ENR*, July 2 and 9) held June 22-26 at Harvard University, 160 papers in all. Brief summaries of a few of these papers of most interest to the practicing engineer have been prepared for publication in this and a subsequent issue. Selection generally has been confined to procedures and devices for field use. A much greater fertility of invention has been shown in laboratory devices and methods, the papers on which alone would make a thick volume. The reader who is interested to study fully into soil mechanics as developed by the conference proceedings should arrange to secure the three volumes of abstracts and discussions through the secretary of the conference, Arthur Casagrande, Harvard Graduate School of Engineering, Cambridge, Mass. The following are summaries of selected papers.

Asphalt stabilized samples

In ground investigation preparatory to building the Maas vehicle tunnel in Rotterdam, Holland, deep samples of sand that could not be obtained in undisturbed form by ordinary methods were secured by temporarily impregnating the sand with asphalt. The operation as described in a paper by J. P. Van Bruggen, engineer of public roads, Rotterdam, was as follows:

A cased 6-in. hole was bored to a depth of about 73 ft. to the sand and with the casing filled with water the impregnating solution was pumped in through a pipe extending to the bottom of the casing. The solution was a quickly-coagulating asphalt emulsion. It penetrated the sand at the bottom of the hole and formed an impregnated bulb which in about 10 days was cohesive enough to allow coherent samples to be taken with a cylinder sampler of regulation type. In the laboratory the sample set vertically was pushed out of the case and a cake 2 cm. thick was cut off and inserted in a brass ring. This ring and sample were then placed in the apparatus shown by Fig. 1 and the asphalt was washed out of the sand sample which was then tested for consolidation. Briefly the washing liquid in the beaker, evaporated by flame, rises in the tube and is condensed by cooling coils to trickle down through the sand sample; about three washings with clean liquid are sufficient. Reliability of the test was predicated on trial tests on sand where undisturbed samples could be secured; comparison of natural and impregnated sample tests gave satisfactory results.

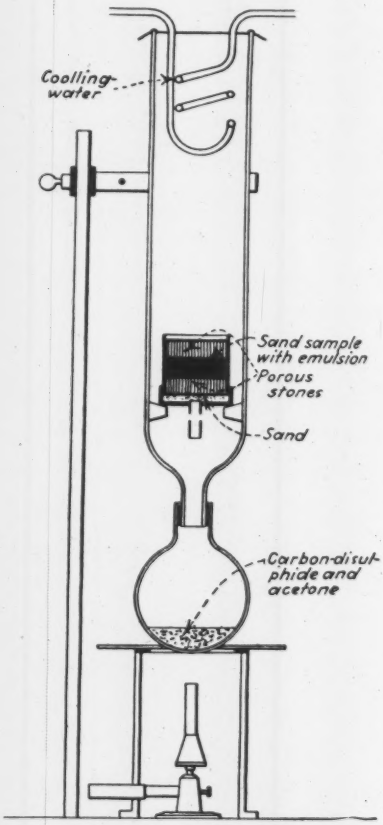


FIG. 1—BITUMEN SOLIDIFIED sand samples debituminized for laboratory tests by this leaching apparatus.

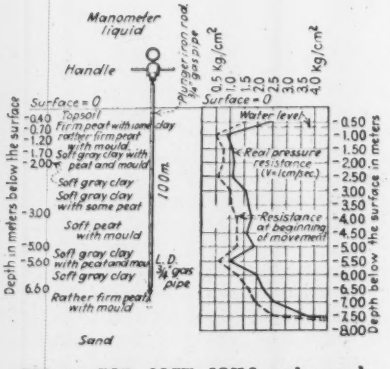


FIG. 2—FOR SOFT SOILS under road embankments successful use is made in Holland of cone penetrometer records.

Cone penetrometer surveys

For roadbuilding in Holland on deep soft clay and peat soils overlying sand resistance determinations have been made by a cone penetrometer described by P. Barentsen. A ¾-in. pipe is fitted with a cone attached to a steel rod which extends up through the pipe; cone and rod are not fixed to the pipe but can move up and down about 6 in. in respect to the pipe. The cone has side angles of 60 deg. and a base area of about 1½ sq.in. In operation the pipe is forced into the soil in stages of about 20 in.; at each stop a pressure gage is attached to the cone rod and cone and rod are forced farther down independent of the pipe for about 6 in. at the rate of about ½ in. per sec. and the pressure is registered and the reading plus the weight of cone and rod is recorded. A penetrometer record for a typical soil is shown by Fig. 2; note the smaller resistance at the start of cone penetration. An even speed of cone penetration is important as the elastic and plastic soils give different results at different speeds. In road fills on clay it has been found that clay movement occurred when the fill load equalled three-eights of the determined test-pressure resistance. From experience Mr. Barentsen concludes: "The particulars gathered in this way make it possible to predict with a tolerable certainty, on the basis of comparison with works previously executed, the behavior of the undersoil, when road embankments are carired out." The cone test is suitable only for very soft soils; it takes about 15 min. for each pressure reading using the device described above.

Another and simpler cone penetration test is described by O. Godskesen, geotechnical engineer, Danish State Railways. The stratification of the Danish moraine formations is very irregular, and furthermore, he says, the qualities

of the clay samples often change considerably in the period between the recovery and the laboratory test. Finally the time element in the case of most construction work does not permit waiting for detailed laboratory information. For all these reasons, since 1931 a cone penetrometer has been in use in all important foundation problems of the railways.

The 60 deg. steel cone is pressed into the untouched surface of the clay, the peneteration being registered on a scale, firmly fixed in the clay next to the cone. The firmness index is defined as the weight of kilograms necessary to press the cone 10 mm. down into the clay. This weight is registered by the maximum indicator of the scale on the shaft of the spring-scale. Thus it is, in a very short time, possible to obtain a number of readings vertically in the bottom of the excavation or horizontally in the sides or even in a sample of sufficient size.

The spring scale consists of two springs of which the outer and most flexible functions alone up until four kilograms, while the inner and stiffer co-operates with the outer from four to fifteen kilograms.

A number of foundation investigations show, that good firm soil with a safe bearing capacity usually fixed at about 3 tons per sq.ft. corresponds to a spring-scale index $S = 6$ kg. per 10 mm., while less firm soil with a safe bearing power of about 2 tons per sq.ft. gives a spring scale index about 3 or 4 kg. per 10 mm., and poor soil with a bearing value of about $\frac{1}{2}$ to 1 ton per sq.ft. corresponding to a spring scale index of about 2 kg. per 10 mm.

Lottery building foundation

A novel experiment in heavy building foundation construction on the treacherous soil of Mexico City was described by Jose A. Cuevos, civil engineer. The theory of design was to "float" the building by excavating a weight of soil exactly equal to the weight of the new building. To observe the rise of the subfoundation soil during its unloading by removal of old buildings and excavation, a number of sub-grade observation points were established. These consisted of cylinders sunk well below the bottom of proposed excavation; the holes were bored several feet below the cylinder bottoms and in these bottom spaces were set concrete shoes inserted through the cylinders and carrying rods reaching above the surface. The weight of shoe and rod was made equal to the weight of soil removed from the test well. Observations taken on the rods during excavation showed an irregular but continuous rise of the ground to a maximum lift of about 4 ft.

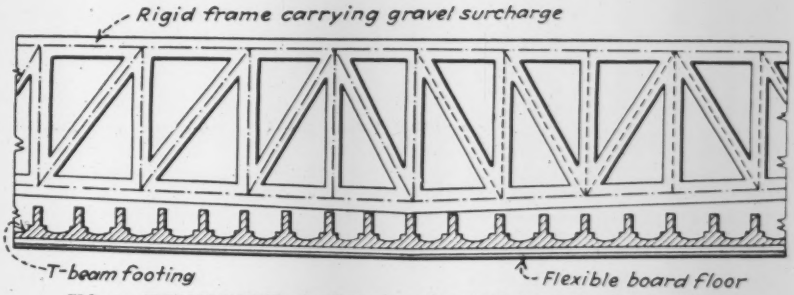


FIG. 3—ARRANGEMENT of substructure of national lottery building in Mexico City designed to secure presettlement of ground for erection of superstructure.

As the excavation was completed the bottom was covered with a flexible flooring of boards carpeted with a waterproof membrane; on this flooring were laid inverted T-beams of reinforced concrete spaced tight but so connected that they had sufficient flexibility to move downward with settlement. On the T-beams was set a rigid substructure of reinforced concrete trusses (Fig. 3) on which was placed a surcharge of gravel sufficient to make the combined weight of flooring, substructure and gravel equal to the calculated weight of the building superstructure and that of the old buildings and excavation removed.

The expectation is that the surcharged substructure will, after a few months, bring ground movement to a point of stability at which erection of superstructure may proceed without disturbing the soil equilibrium that has been attained. As the structure is carried up equal weights of the gravel surcharge will be removed. As of April this year the excavation was nearly finished, about 80 per cent of the flooring and 70 per cent of the T-beams had been placed and the framed substructure had been started.

Compacting new earth fills

The new program of express-highway construction in Germany (*ENR*, July 5, 1934, p.10) calls for the construction of high-type pavements on new fills and to reduce possible fill settlement damaging to the pavement, extensive trials have been made of compacting devices and methods. As a basis for comparison a determination was made of pore space, grain size and coefficient of uniformity. An arbitrary scale was established ranging from the pore space of the loosest state as 0 per cent to the densest obtained in the laboratory as 100 per cent. Only cohesionless soils (sand and coarse sand fills) are considered.

FIG. 4—POWER SHOVEL dropping two to four ton weights about 5 ft. proved to be one of the most effective methods of compacting sand fills.

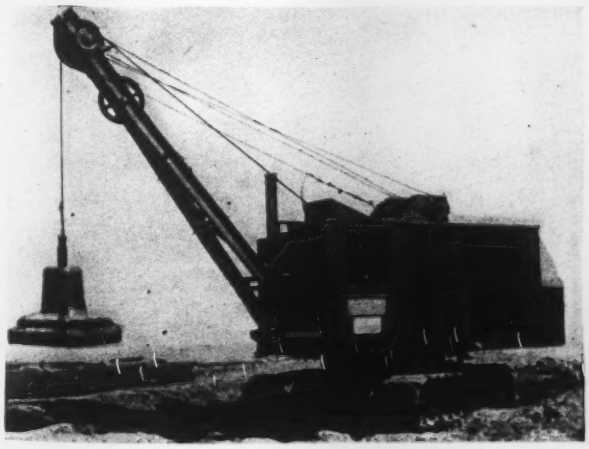
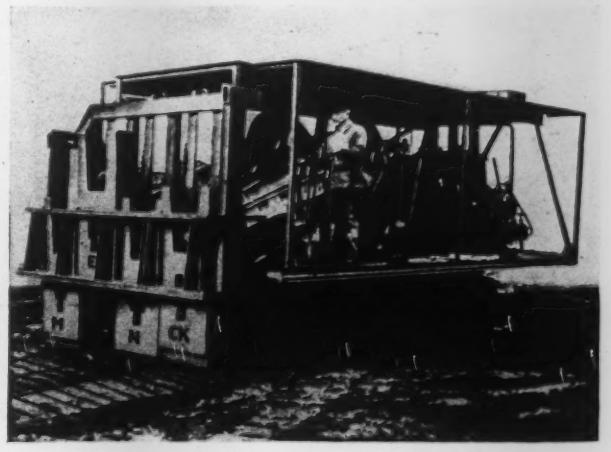


FIG. 5—GOOD COMPACTION was had with a traveling tamping machine operating four 1½-ton tampers.



Neglecting ponding, which proved ineffective, and washing which produced a hydraulic fill, with characteristic beaches and core, unsuitable for a road fill, the compacting processes were all mechanical except one experiment with jetting and another with gravel piles. The methods, with illustration of each, were as follows as described by Wilhelm Loos, Technische Hochschule, Berlin, Germany:

Tamping devices

With the beginning of work only general equipment was available and compacting was begun with heavy flat weights raised and let fall by a crawler-mounted power shovel shown by Fig. 4. With 2-ton weights dropped about 5 ft. the effect of compaction extended to a depth of about 40 in. Tamping combined with ponding showed that better results in sands with uniform grain size were had with dry tamping alone. Tests with different weights showed that with weights over 4½ tons no increase in compaction was obtained; the greater force of the blow disturbed and loosened the soil.

Among special machines particular use was made of the explosion tamper known as the Delmag frog and illustrated by Fig. 6. Contractors prefer this machine because it is more adaptable to varying conditions and costs about one-eighth the cost of the shovel and falling weight previously described. The frog tamps strips about 2½ ft. wide by successive jumps induced by oil explosions. The frog weighs about 2,200 lb. The compacting action is not so deep as that of the dropped weights but the effectiveness is high and about 650 machines are now in use in constructing the express highways. (A tamper of this type used in building the San Gabriel dam was described in *Engineering News-Record*, May 14, 1936.)

Multiple hammer tampers include a compressed-air machine and a new special machine shown by Fig. 5. The compressed-air machines were rather expensive and their light hammers were effective to less depths than the dropped weights. Only one of the machines shown by Fig. 5 has been used and this not enough to give a job test; it is said to work satisfactorily. The machine travels on crawlers and has four 1½-ton hammers; it will compact about 600 sq.yd. an hour.

Vibration, jetting and rolling

Two methods of vibration were tried, one using the powerful machine shown by Fig. 8 and the other using high frequency surface vibration in combination with jetting. The machine shown by Fig. 8 weighs 25 tons and vibration impulses are given to the bull-nose shoe by a 70-hp. engine rotating unbalanced steel weights. Results of compaction with this machine compared with oth devices are shown by Fig. 9. Curve shows the average compaction of t natural soil from the borrow pit; Cur II shows the density of the uncompact fill; Curves IIIa and IIIb show the after compaction with dropped weigh the difference being due to more blo in one case; Curve IV shows compacti with the vibrator moving ahead a Curve V with it at a standstill.

In the other method of vibration wa is injected through jet pipes and t surface is vibrated at the rate of 3,0 impulses a minute. Two methods a being studied with the jets arranged shown by Fig. 10. The compaction very high but the soil must be permeabl

In another test in sand about 50 deep soil consolidating piles of th Franki type were driven; steel cylinde were driven and cleaned out and th gradually withdrawn as gravel fillin was placed and compacted by a 3-to hammer. The driving lowered the san surface about 3¼ ft. and the pore spac was reduced from 42 to 35. Fig. 7 shows one of the gravel piles after th sand had been excavated from around it to be of almost concrete consistency.

Rolling was not successful in sand, the rollers skidded and stalled. The success was greater in cohesive soils and in compacting coarse gravel with sand.

Commenting on the experiments, Dr. Loos stated:

> To obtain some idea about the required density for road subgrades, we examined old railroad or road embankments. First we tested two fills made in 1923; one of them had never been used up to 1935, the other one had been used for railroad traffic all the time; the compaction in the first case was 10 to 20 per cent and in the second about 60 per cent. Another test was made on a road fill of clay-sand more than 100 years old; it showed the high compaction of 82 per cent.
>
> Natural soil is never found at its highest density; we found it between 20 and 40 per cent of our scale. I should say, there-

FIG. 7—A GRAVEL PILE for fill compaction when uncovered showed almost the solidity of concrete.

FIG. 6—THE DELMAG FROG proved the compacting device most popular with road contractors who have about 650 of them in use.

FIG. 8—A 25-TON VIBRATING DEVICE operated by a 70-hp. motor giving impulses to a bull-nose shoe.

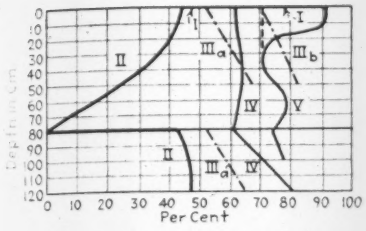


FIG. 9—COMPARATIVE COMPACTION curves showing efficiency of the vibrating machine shown by Fig. 8.

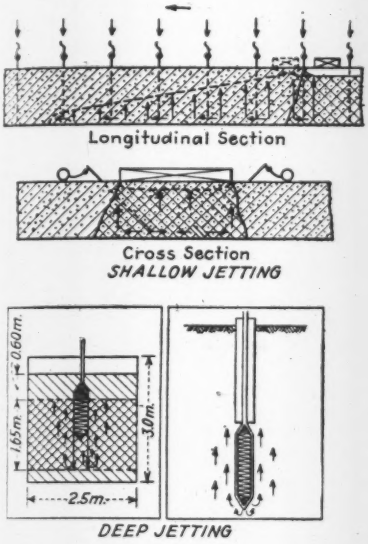


FIG. 10—METHODS of shallow and deep jetting used in combination with high-frequency surface vibration.

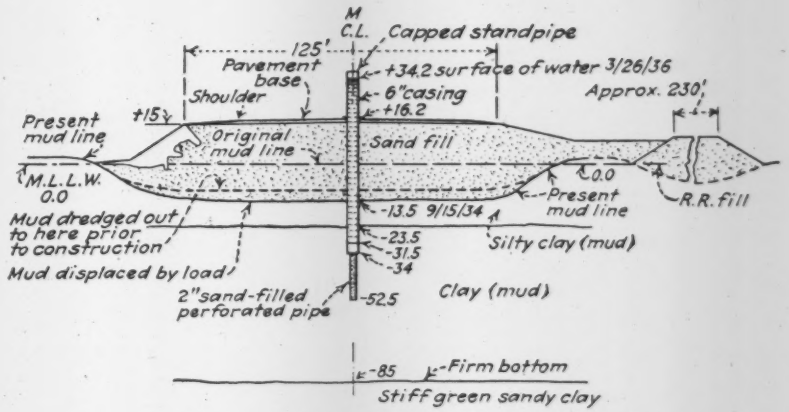


FIG. 11—STANDPIPE ARRANGEMENT in road fill over mud to determine hydrodynamic pressure of water in saturated strata under fill load.

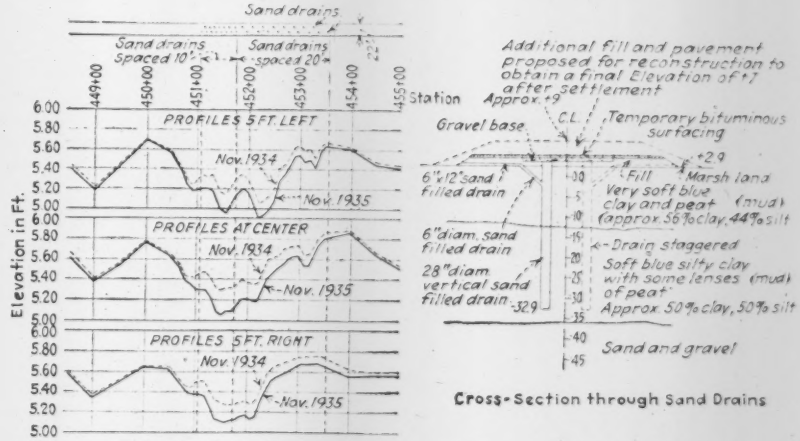


FIG. 12—VERTICAL SAND DRAINS in road fill over marsh increase rapidity of fill settlement.

fore, about 50 per cent in an embankment is sufficient. Standards should not yet be set and good uniformity is much more important than a high density in various places. The effect of the described methods depends on the grain size distribution; for instance, non-uniform sand reaches in general a higher record of compaction than a uniform one.

Fill settlement by vertical sand drains

Frequent fills over marsh land in constructing California highways have made the problem of fill settlement of serious import to the state road engineers. Various observations from previous experience were finally brought to a test with the necessity of building the eastern embankment approach across mud flats to the San Francisco-Oakland Bay Bridge. Three sets of tests were undertaken as described by O. J. Porter, California Division of Highways: (1) Laboratory tests to determine probable effect of vertical sand grains; (2) field study of hydrodynamic pressure under a fill over a saturated foundation preliminary to field construction including the use of vertical sand drains, and (3) construction of vertical sand drains in a fill over saturated marsh land and observation of subsequent fill settlement over an extended period of time.

Standpipe Test—On the bridge approach fill as shown by Fig. 11, a 6-in. casing was driven through the fill into an impermeable clay-mud stratum. This casing was cleaned and made absolutely shell tight to El-34. Inside the casing from El.-32 to El.-53½ a 2-in. perforated sand-filled pipe was driven thus allowing water below El.-34 to pass upward through the casing. A hydrodynamic pressure of about 1 ton per square foot was measured or a pressure about equal to the fill load applied.

The standpipe, it was considered by Mr. Porter, furnished reliable information regarding the active pressures producing consolidation and instability of saturated soil. As hydrodynamic pressure acts laterally as well as vertically, it is proper to assume that such pressure is a vital factor in connection with fill slip-outs. Stabilization of the foundation under such conditions can be accomplished only by special drainage treatment. In connection with the bridge-approach fill Daniel E. Moran, consulting engineer, suggested sand piles for drainage and lateral compaction of the mud. The subsequent vertical sand drain tests were undertaken to prove this suggestion.

Laboratory Test—A small-scale laboratory experiment was made. The specimen with sand drains consolidated 20 to 25 times faster than the untreated specimen.

Field Tests—On a 2-mi. road over marsh three test sections totalling 431 ft. of road were provided with vertical sand drains as shown by Fig. 12. A total of 84 holes 28 in. in diameter were sunk to an average depth of 42 ft. and filled with clean sand of about the character of coarse concrete sand. The longitudinal spacing of the holes was generally 10 or 12 ft. but in one section for about 175 ft. they were 20 ft. apart as shown by Fig. 12. The drains were installed in November, 1934, and the curves show the acceleration of settlement.

From these investigations Mr. Porter has concluded that: (1) Drains, with a spacing consistent with the type of material and the desired rate of loading, readily release the excess water, relieve the hydrodynamic pressure, and thus prevent lateral displacement during fill construction, and (2) it is possible, with proper spacing of the drains, to obtain practically all of the settlement during six months to one year's time.

FIRST OF A SERIES ON

MOSQUITO CONTROL ENGINEERING

SHORTLY BEFORE the turn of the century, prior to the discovery that mosquitoes were the transmitting agents of several human diseases, malaria and yellow fever epidemics throughout the world were considered as necessary evils. After proof of the discovery had been worked out in convincing fashion, attempts were made to eradicate the winged pest wherever these diseases were prevalent—the most dramatic campaign taking place on the Isthmus, where its success made possible the construction of the Panama Canal. Since that time there has been a growing interest by engineers and by the public in the extension of abatement programs, based on a more general appreciation of the real economic significance of mosquito eradication. Although yellow fever has been practically eliminated, the plague of malaria is by no means subjugated; in addition the eradication of pest mosquitoesfi as distinguished from disease-transmitting species, is in itself a measure of far-reaching importance.

With but very few exceptions, engineers have been prone to regard mosquito control as an activity of minor importance—largely the business of entomologist and sanitarian. The fact is, however, that the administration of a successful abatement program—the results of which have a profound effect on real estate values and the protection of public health—requires the broad application of established engineering principles. Paradoxically enough, it is the engineer also who is the greatest contributor to mosquito propagation and the sponsor of possible disease epidemics, because in his designs for highways, reservoirs, irrigation projects and other modern structures he frequently fails to incorporate provisions for adequate drainage of shallow, stagnant water.

AS A MEANS of acquainting engineers and public-works administrators with the vital importance of mosquito eradication in its relation to the economic well-being of their communities, we begin in this issue the first artcle of a series on mosquito control engineering. The specialized knowledge on the subject is not readily available to most of those charged with the responsibility of maintaining public health and comfort. It is the hope that this symposium of authoritative information on control measures may give added impetus to systematic efforts against man's prime insect enemy.

The Growth and Importance of Anti-Mosquito Work

●Entomologists, medical men and engineers are united in a world-wide crusade against an insect which is an undesirable inhabitant of the earth, bringing disease, discomfort and other economic losses to man.

By DR. L. O. HOWARD
Formerly Chief, U. S. Bureau of Entomology

PERHAPS it may be difficult to realize that only thirty-eight years ago, mosquitoes were looked upon merely as nuisances—beastly nuisances of course—that made localities unfit for habitation, agricultural uses and industrial pursuits. So, throughout our country and many others, mosquitoes with their sinister song and bite were considered a necessary summer annoyance and millions of dollars were spent in screening windows and porches.

It was in Calcutta in 1898 that Major Ronald Ross of the Indian Medical Service discovered that malaria is carried by certain mosquitoes and his results were almost immediately verified by Battista Grassi and his colleagues in Italy. This was a startling announcement! People all over the world gave serious thought to the matter because malaria was acknowledged to be one of the worst diseases affecting mankind. Although the actual number of deaths from malaria itself was not enormous, the workers in a malarial region were inefficient or soon became so, and malarial individuals were easily susceptible to a multitude of other ailments that ultimately caused death. It produced what the doctors called a cachectic condition.

Some of the richest agricultural regions in the world could not be exploited because they were so malarious that no human could live there. Other regions equally rich were inhabited only by a few miserable "fever and ague" families. So widespread was the danger from malaria that when I came to Washington in 1878 for example, we used to take a mouthful of sulphate of quinine every morning before breakfast.

It would be difficult to overestimate the importance of malaria in the history of the world: it has enfeebled and contributed to the downfall of many nations including ancient Greece and the old Roman Empire; it has immensely retarded progress, and caused the untimely death of untold thousands.

The news of Ross' discovery galvanized the world into action. If the *Anopheles* mosquitoes alone carried the disease, it was perfectly obvious that we must destroy the mosquitoes, and so work was at once begun in many countries. We people in Washington published a complete bulletin on the subject and a year later I wrote a book. Over in England Fred V. Theobald wrote a comprehensive monograph. Raphael Blanchard did the same in Paris. In

Italy a great organization was developed headed by Grassi and Angelo Celli, supported by government appropriations and by a large sum from the privy purse of the King. The English colonies began work at once with the Indian Medical Service taking the lead. Major Ross himself made a survey of conditions in Greece. The Dutch Government subsidized activity in the East Indies where careful studies were made, the earliest ones being done by Swellengrebel. Thus the campaign against the winged pests was launched.

One of the first things discovered was that there are many more different genera and species of mosquitoes than we had supposed, and what is much more important, that some of the various kinds develop and live in different ways and under different conditions. This was a really practical discovery and has lead to much effective work and to the abandonment in certain localities of much unnecessary and ineffective effort.

For example, when I first worked out the life history of an *Anopheles* mosquito back in 1898, I found that it laid its eggs, not in a raft shaped mass as does the common rain-barrel mosquito of the northern United States and France but scattered singly on the surface of the water, and what is much more important, that the larvæ or "wrigglers" on hatching from the eggs do not feed on minute organisms held in suspension below the surface of the water, but upon such objects floating on the surface film. The discovery, while not doing away with the efficacy of the early and well-known kerosene treatment, led to the adoption of adulterated arsenical powders blown from aeroplanes or otherwise upon the surface of stagnant waters and marshes.

The salt-marsh mosquito

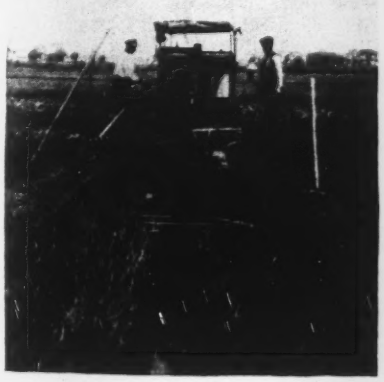
Another very important discovery illustrating the radically differing habits of mosquito species was made by Dr. John B. Smith who went from the U. S. National Museum at Washington to the New Jersey Agricultural Experiment Station at New Brunswick (where he spent the rest of his useful life) to study the notorious New Jersey mosquito. He found the common and rain-water barrel species of course, and he found those forms that breed in the swampy inland regions. These, however, were not the mosquitoes that appeared during the summer in such incredible numbers. He found that the species which gave New Jersey its unenviable reputation breed only in the salt marshes that border the sea-front of that state, that they can fly from these marshes for at least 40 miles inland, and that they lay their eggs, not in the water but in the mud at low tide, hatching only when the highest tides reach them. This discovery was of the greatest practical value and led directly to the beginning of large appropriations by the state and various counties to carry on extensive diking and drainage ditch construction on the salt marsh lands—both engineering procedures occupying the attention of many competent and well-known engineers. Indeed a famous engineer, Spencer Miller, has been called the "Father of mosquito extermination in New Jersey."

This, be it noticed, was work not connected with the elimination of disease but concerned primarily with nuisance abatement which directly affected real estate values. The success of this work has been reflected in summer resort profits as well as in a great increase of suitable sites for new manufacturing enterprises. The expenditures have been repaid many times over in increased tax values and in other ways all of which have been evaluated and described in New Jersey state reports by Dr. Thomas J. Headlee of New Brunswick, the extremely able successor to Dr. J. B. Smith.

The salt-marsh mosquitoes have many relatives that share their habit of not laying eggs in water but on the ground where water, such as pools formed by the melting snow, causes them eventually to hatch. These are the prevalent mosquitoes of many of our northern summer resorts in rather high-lying forested regions like the Adirondacks and the Catskills and extensive country in Maine, northern Michigan, Wisconsin, Minnesota, British Columbia and the northwestern states. The control of these mosquitoes offers a problem that calls for the attention of engineers.

The New Jersey investigation and the work begun there attracted wide attention in regions where salt marshes abounded. The so-called "North Shore Improvement Association of Long Island" took it up and there was begun an extensive filling in of marshes near Flatbush with material obtained from Brooklyn, N. Y. ash barrels. Connecticut became active on the other side of Long Island Sound, and at points on the Massachusetts coast funds were

FIG. 1—SALT MARSH ditching with machines simplifies control work.



ARTICLES AND AUTHORS

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Dr. L. O. Howard
Formerly Chief, U. S. Bureau of Entomology

II—MOSQUITOES: SPECIES AND HABITS
Dr. Thomas J. Headlee
New Jersey State Entomologist

III—CONTROL TECHNIQUE AND ORGANIZATION
Russell W. Gies
Sanitary Engineer, New York City Dept. of Health

IV—INLAND CONTROL METHODS
J. Lyell Clarke
Sanitary Engineer, Des Plaines Valley, Ill., Mosquito Abatement District

V—THE SALT MARSH PROBLEM
Ralph J. VanDerwerker
Supt. Union County, N. J., Mosquito Extermination Commission

VI—MALARIAL MOSQUITO CONTROL
Dr. L. L. Williams, Jr.
Senior Surgeon, U. S. Public Health Service

VII—SYMPOSIUM ON REPRESENTATIVE OPERATIONS
Delaware.....*W. S. Corkran*
Executive Officer & Engineer, Delaware Mosquito Control Commission
California.....*Harold F. Gray*
Engineer, Alameda County Mosquito Abatement District
Mississippi Valley, *J. A. LePrince*
Senior Sanitary Engineer, U. S. Public Health Service
New Mexico.....*C. M. Adams*
Asst. State Director, Malaria Control Program, U. S. Public Health Service

FIG. 2—WOODLAND swamps must be drained in order to curtail breeding.

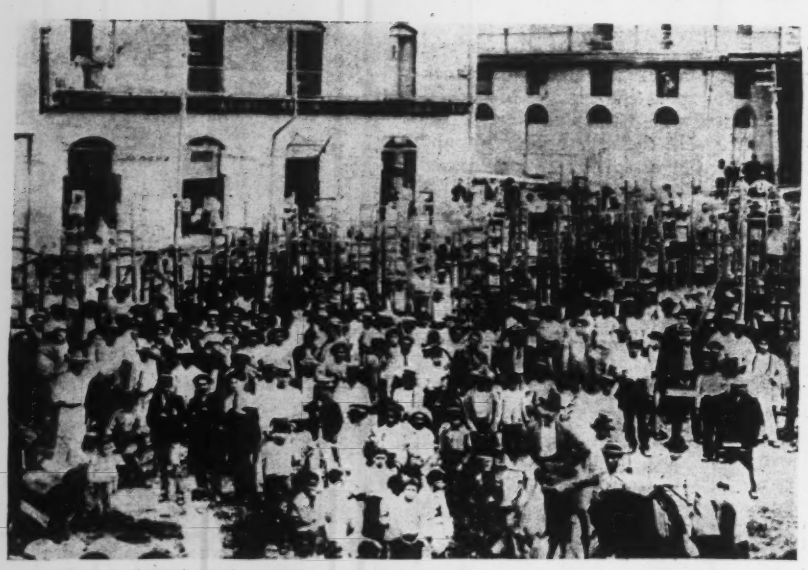


FIG. 3—FUMIGATION BRIGADE in the 1905 Panama City campaign against the yellow-fever mosquito *(Aedes egypti)*. Houses were temporarily sealed with paper and then fumigated with sulphur and pyrethrum.

FIG. 4—MUD-CRACKS in the extensive fills made on the Panama Canal created numerous new breeding places for mosquitoes when the cracks filled with rain water. Until this was discovered the recrudescence of malaria after control measures had been effected, greatly puzzled the sanitary engineers.

raised, largely among summer residents, and similar salt marsh work was started. The work on Staten Island, first begun by the late Walter C. Kerr of the firm of Westinghouse, Church, Kerr and Co. and later carried on extensively by Dr. A. H. Doty, while health officer of New York City, should also be mentioned. In California the people of Burlingame got experts from the University of California to begin similar work, and much later, the U. S. Public Health Service undertook control measures in south Mississippi along the shores of the Gulf of Mexico. The unusually long flight range of salt-marsh mosquitoes has made the eradication problem difficult since they are wafted for many miles inland.

In a previous paragraph it has been said that the salt-marsh mosquitoes are not known to carry disease, yet their presence in enormous numbers has a very bad effect upon nervous invalids and upon all but the most healthy individuals.

Yellow fever and the Panama Canal

About the end of the last century came the monumental proof of Carlos J. Finlay's contention that yellow fever is carried by the common house mosquito of tropical and sub-tropical regions. The exact and scientific proof was, as every one knows, gained by the U. S. Army Yellow Fever Commission, consisting of Walter Reed, J. C. Carroll, J. W. Lazaer, and A. Agromonte near Havana at the close of the Spanish-American War. So complete was this demonstration that the world in general accepted it immediately as a proven fact and Havana conducted a mosquito house-cleaning under the charge of W. C. Gorgas, then a major in the medical department of the army. Nearly all of the tropical countries of the western hemisphere became interested and admirable mosquito eradication work was immediately begun, notably in Brazil under Oswaldo Cruz and in Mexico under Eduarado Liceaga.

The first big-scale demonstration of yellow fever mosquito control came in 1905 when this disease appeared in epidemic form in New Orleans. There the attack on the mosquito, under Dr. J. H. White of the U. S. Public Health Service, was carried on so successfully that the threatened epidemic was arrested and thousands of lives were saved. No further outbreak of this terrible disease has since occurred in the United States and it seems probable that there will never be another epidemic. People of my age remember only too well the financial failures, the stoppage of business, the flight of labor and the infinite suffering and sorrow which surrounded these epidemics that occurred occasionally as late as the close of the last century.

We all know about the war on mosquitoes during the building of the Panama Canal. As the yellow fever mosquito is distinctly a household species (so much so that it may almost be called a domestic species), and because it is not a strong flier, it was possible for Dr. Gorgas and his trained assistants from the Havana campaign, to reduce its numbers very rapidly in the Canal Zone. But malaria was also rife in the Zone and not only were *Anopheles* breeding places numerous, but new breeding places were made during the canal construction work.

For example, when the moist mud of very extensive fills dried on the surface under the sun in the so-called "dry-season," it cracked greatly and, with the occasional showers, the cracks were filled with water. To understand this, one must remember my old colleague E. A. Schwarz' definition of the "moist tropics" as compared to the "dry tropics" which he knew much better. He stated, "In the moist tropics there is a dry season and a wet season; the difference being that in the dry season, it rains every day, and in the wet season, it rains all the time!" Now when the mud cracks got a little water in them, the malaria-bearing mosquitoes found a new place to lay their eggs and thus thousands of new breeding places came into being. Mosquito broods coming from these cracks brought about an unexplained recrudescence of malaria which at first greatly puzzled Gorgas and his assistants. It is interesting to note, at this point, that it was an engineer—J. A. Le Prince—who had been with Dr. Gorgas in his clean-up in Havana who discovered this entirely new breeding place and who devised methods for its

elimination. *(Mr. Le Prince is the author of an article in this series—Editor.)*

After the canal was carried to its triumphant conclusion it was frequently asserted that in its construction the sanitary problem was quite as great as the engineering problem; however it is not generally appreciated that in the sanitary work the engineer played a vital rôle. It has also often been said that this work demonstrated the possibility of the opening of the tropics to healthy occupation by the white race.

Other diseases carried by mosquitoes

There are other diseases aside from malaria and yellow fever that are carried by mosquitoes. The oriental and tropical troubles that are brought together under the name of *filariasis* (elephantiasis is one form) was the first to be demonstrated. This was done by Dr. Patrick Manson of England at a time antedating Ross' discovery concerning malaria. It was a discovery that first put Ross on the right track and in fact it was Manson who advised Ross in his initial investigations. It is interesting to know that, as the late medical inspector Ames of the U. S. Navy once told me, the medical men on the war vessels assembled on the China station, were so incredulous of Manson's theories that they used to chaff him about his fixed ideas and to speak of him among themselves as "Crazy Pat Manson."

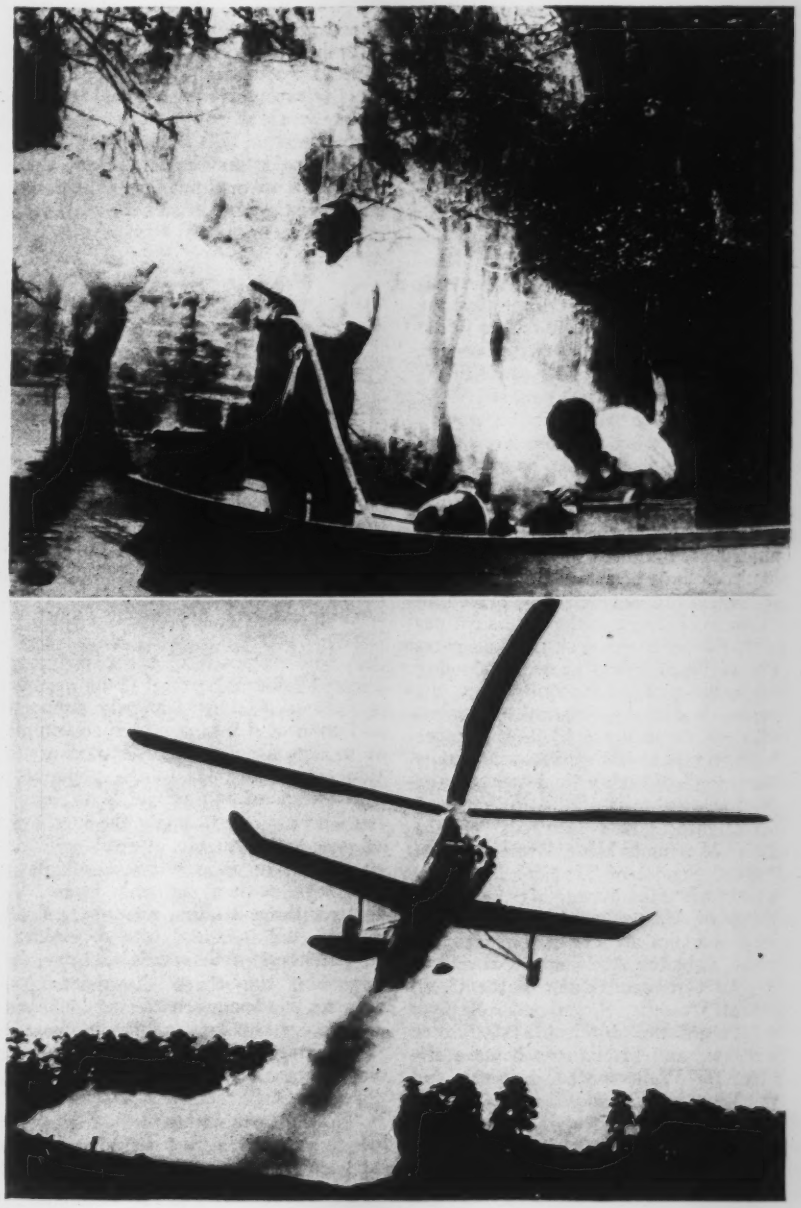
There is another disease of warm climates quite frequently found in the southern United States called "dengue" or sometimes "break-bone" fever. The carrying of this very painful illness by mosquitoes was long suspected, but the actual facts were never established until an army commission headed by Colonel Siler made an extensive investigation in the Philippines and eventually indicted the same old "day mosquito" of the tropics—the transmitter of yellow fever—as the culprit. This was a splendid piece of investigation and one which has led or will lead to the control of the disease.

Mention of the Philippines reminds me that the occupation of these islands being so nearly coincident with Ross' great discovery and the yellow fever announcements by Reed, Carroll, and Lazaer, naturally caused a great interest in mosquitoes in the South Pacific. Miss Clara S. Ludlow had journeyed out there with her brother, Colonel Ludlow of the U. S. Army and at once began a study of the mosquitoes to be found in the Islands. She carried on her work for several years, and upon returning to Washington was given the degree of doctor of philosophy by George Washington University, submitting a thesis on the mosquitoes of the Philippines. About this same time, C. S. Banks who had been an assistant to Dr. Felt, the State Entomologist of New York, went to the Islands and instituted further investigations. Later the health board of the Rockefeller Institute sent Dr. W. V. King of the U. S. Bureau of Entomology there to continue these studies, and intensive remedial and investigatory work has been pursued by the Institute, by the Philippine Bureau of Science, and by the medical department of the U. S. Army.

Growing appreciation of control

The anti-mosquito crusade is spreading all over the world. Governments, local health boards, private commercial enterprises such as planters' associations, and industrial concerns, have capitalized and supported in many ways, not only large scale practical work, but research as well. A rather early experimental study of the efficiency of labor as influenced by mosquito control measures in a malarious cotton growing district was started at Mound, Louisiana, under D. L. Van Dine of the U. S. Bureau of Entomology. It may parenthetically be stated as Herrick had pointed out earlier, that the productiveness of the Mississippi Delta—a region of the very richest agricultural possibilities, quite comparable to, and possibly superior to the valley of the Nile—had always been held to be a low point of development by the disastrously preva-

FIG. 5—"DUSTING" the surface of stagnant waters and marshes with adulterated arsenical powders destroys malaria mosquitoes in the "wriggler" stage as they feed on the surface. The men in the boat are applying the powder with a power gun; the lower view shows an autogiro laying a dust barrage.



lent malaria that undermines the morale of the inhabitants.

As an example of the organization of such work as I have mentioned, and at a much later period, I may relate that in September, 1931, when my vessel was lying at anchor in the harbor of Punduloya, Ceylon. I was visited by an efficient, learned and important looking gentleman whose card told me that he was the "Chief Malariologist of the Tea Planters' Association of Ceylon." In our subsequent conversation I learned how the tea growers of this region had found it necessary to organize extensively against malaria and malaria-bearing mosquotoes to preserve and increase the efficiency of their labor. The tremendous outbreak of pernicious malaria that swept over Ceylon two years later in spite of the precautions already taken must have caused the planters to greatly fortify their anti-mosquito work.

Still another instance of the high appreciation that has grown up and is rapidly increasing, of the enormous importance of what they be called "Medical or sanitary entomology" may be given. In 1932 Dr. Simon Flexner of the Rockefeller Institute appointed me to represent this organization at the Fifth International Congress of Entomology in Paris. There was a section of so-called "medical entomology" at this meeting, and its importance was thus recognized for the first time by the greatest private health foundation in the world. Anti-mosquito work, of course, is one of the greatest of its problems.

Now to come down to more recent times. It may be true that the world's financial depression, lasting from 1929 almost to the present time, has, in some places, slowed the tempo of some of the practical work. Indeed, some of my friends who go to the seashore for the summer have told me that in recent years mosquitoes have been rather more abundant than in the summers just preceding the slump. However, the published papers that come to my desk from all parts of the civilized world show no slowing down in the study of mosquitoes and the diseases they carry—instead there has been a steady increase in their number and importance. Mosquitoes are now studied in all of the medical colleges and in most medical research institutions.

Investigators like Edwards of the British Museum, Miss Evans of the Liverpool School of Tropical Medicine, Martini of Hamburg, Mrs. Bonne-Wepster of Amsterdam, and many other earnest workers are constantly carrying on most valuable research. Many have died, like Dyar and Knab of the U. S. National Museum, Sir Andrew Balfour who started the admirable station at Khartoum, and afterwards became the head of the Wellcome Laboratories and of the London School of Tropical Medicine, and E. A. Macgregor, who did remarkable work in Mauritius; but others of a younger age have taken their places, and the work is vigorously going forward. Now, from Saskatchewan to Valparaiso, from the Maine coast to Rio de Janeiro, from Japan to the Philippines and Australia, from the Dutch East Indies through British India to Belgrade in Jugo-Slavia, from Greece, Italy and Spain down to South Africa, there are ardent workers. Many of these view the question largely from a medical side, but they call on the engineer for aid and practical application of their findings. There is no doubt that the engineering colleges, if they have not begun to do so already, will soon begin wider instruction in mosquito control engineering.

One of the Surgeon General Gorgas' assistants who had been with him during the digging of the Panama Canal, wrote me during the World War in reply to a suggestion of mine that they should employ entomologists in the great concentration camps, virtually as follows: We don't need entomologists —men trained to count the spots on a mosquito's wing, but sanitary engineers, such as we used in Panama. He was stupidly wrong about entomologists but perfectly right, of course, about the engineers.

The reader may raise the question—why did the world put up with the mosquito scourge before 1898—why did it endure the disease, the great mone[illegible] loss, and the irritation and suffering caused by these insects until a dramatic discovery literally forced it to go to work? The answer was indicated two or three years ago by a five-year old girl who was sitting in the garden near New York playing with my eldest daughter. My daughter waving her hand irritatedly about her head, said: "Oh! these mosquitoes! But they wouldn't be quite as bad if they didn't bite!" "Well," said the little girl with an air of confirmed wisdom and indifference, "That's their job!"

That statement undoubtedly is the answer. The world looked at mosquitoes before 1898 in just the same way as did my daughter's philosophical little friend. Now, however, the fight is on in full force. We realize, in rather full measure what mosquitoes have done to us, and what they will do if we are not triumphant in the end.

The second article in the series describing the characteristics of various mosquito species in relation to control measures has been written by Dr. Thomas J. Headlee, State Entomologist of New Jersey and will be published in the issue of Aug. 6.

Power Plants and Earthquakes

EARTHQUAKES, according to the evidence of geology, are likely to occur anywhere in the United States and engineers should take account of them in the design of their structures according to P. E. Stevens of the Byllesby Engineering and Management Corp. who presented a paper on power plant design at the Midwest Power Conference in Chicago. The following extracts are taken from Mr. Stevens' paper:

A power plant is an exceedingly complicated assemblage of building and equipment masses, elastically supported and connected into a system so complex as to defy accurate and detailed prediction of its behavior in the presence of any source of vibration. Many efforts have been made to apply the mechanics of steady, harmonic, forced vibration to the study of earthquake effects on buildings of conventional design. Although these studies are academically correct within the limits of accuracy of the assumptions made and the data available, the three dimensional, irregular, jerking, chattering vibration of an earthquake, within its zone of destructive violence, is neither steady nor harmonic, although the element of force must be admitted.

The determination of the forces which must be exerted within a structure to keep it intact when its foundation is abruptly and irresistibly moved is unquestionably a problem in dynamics. The applied forces which must be dealt with are in reality inertia reactions resisting acceleration, and before they can be ascertained it is necessary to know the values of the following elements of the problem:

1. The magnitude of the applied acceleration.
2. The rate of change in acceleration, or
3. The time through which each acceleration value acts.
4. The elastic properties of each path by which acceleration may be transmitted to each mass in the structure.
5. The damping effects of each such path.
6. The magnitude of all masses involved.

Only the sixth item can be even closely estimated from any certain knowledge which is now available, and until much more becomes known about the other five elements no exact solution in mechanics is possible. Furthermore, academic solutions based on approximations may be very misleading.

Earthquake design recommendations

In designing buildings for earthquake resistance it is, therefore, necessary to be guided by the result of skillful interpretations of observations on structures that have withstood earthquake shock and others that have not, and to apply

all rules in the light of one's knowledge of dynamics. A vast amount of information has been collected and a distinct literature developed by engineers in this field but it is only recently that the subject has been given any attention by writers on structural design. For power plant buildings and incidental structures, the following general recommendations are offered:—

1. Design buildings for lateral forces of 10 per cent of the dead loads and fixed live loads.

2. Design chimneys for a lateral force varying from 20 per cent of gravity at the bottom to 35 per cent at the top.

3. Design water-tank towers standing on the ground for lateral forces of 15 per cent of the total vertical loads.

4. For water tanks on roofs use 30 per cent.

5. Avoid irregular shapes both in plan and elevation. Where such shapes must be used the concentration of stress at angles and junctions must be given most careful consideration.

6. Avoid projecting balconies, canopies, cornices, belt courses, etc.

7. Foundations should be as deep as reasonable expense will permit, and all footings should be strongly tied together.

8. Soil pressures should be conservative and corner piers and footings should be extra large.

9. All members which carry vertical loads or are subjected to horizontal forces should be of material having high tensile strength and resilience.

10. For combined earthquake and ordinary loading, unit stresses may be increased 25 per cent.

After the Long Beach earthquake of March 10, 1933, the officers of the San Diego Consolidated Gas and Electric Co. became somewhat alarmed at the possibility of a similar visitation in San Diego. Some argued that there is no known active fault line extending through the city and that there is no record of an earthquake of destructive violence at that place. There is little logic in such arguments. They are not supported by earthquake history. Wiser counsel finally prevailed and Walter L. Huber, consulting civil engineer, San Francisco, was engaged to survey the various plants of the company, report on the hazard and recommend means of minimizing the danger of serious interruption to service. As a result the strengthening of four buildings was undertaken.

Solid walls put in

Two of the buildings had brick bearing walls carrying roofs consisting of thin concrete slabs on a steel frame. The brick walls were removed and reinforced concrete walls substituted, and in the higher building steel columns were also added. The roof frame was braced and a sturdy border beam of concrete was installed at the junction of the walls and roof.

A more interesting problem was presented in a substation which is of vital importance to the continuity of service. It is located in a residential district and although great care had been exercised to give it a pleasing appearance the matter of earthquake resistance had not been given a thought. The construction is of hollow tile with roof trusses resting on steel columns. In this case additional walls of reinforced concrete, 8 in. thick, were built inside of and against the existing walls and thoroughly anchored to them by means of reinforced concrete lugs poured in the hollow spaces in the wall tile. Horizontal forces equal to 10 per cent of the force of gravity on all parts were used in proportioning the remodeled structure in each of the above jobs.

More bracing in high rooms

The fourth building to be remodeled for earthquake protection is the main generating station at San Diego. It is conspicuously located just across Broadway from the Santa Fe Railroad station and near the docks of the important ocean lines and the navy pier. The south half, built in 1896 is of a mixed classical architecture and, has heavy concrete walls with only a small percentage of reinforcement. The turbine-room trusses are supported on steel columns but the boiler-room trusses rest on concrete piers. The exterior of the north half of the building, which was built in 1927, was designed by a local architect who treated it in the Spanish style so popular in southern California. The structural frame and the reinforced concrete walls were designed in the office of the Byllesby Engineering and Management Corporation and although earthquake forces were not considered, it is not now necessary to strengthen any of the main members.

The older portion of the building could not be considered safe for any considerable shock. The boiler room along the west side of the building is about 96 ft. wide and 40 ft. high, the turbine room 56 ft. wide and 62 ft. high with a basement 18 ft. deep. An electrical bay 14 ft. wide and 62 ft. high extends along the east side of the turbine room. Steel box columns support the crane girders and similar columns in the outside walls help to carry the floor of the electrical bay. Above the level of the crane runway there are columns consisting of 10-in. I-beams in each wall. The webs of the I-columns are perpendicular to the plane of the roof trusses which rest on the top of them thus offering a minimum of resistance to lateral forces.

In the preparation of the design for strengthening, advantage was taken of all available space in the electrical bay to install new cross bracing and portal struts. The flexible length of the columns was thus reduced, restrained ends were established and the stiffness of the structure greatly increased. The columns in the west wall of the turbine room will be strengthened by the addition of 21 in., 112-lb. wide flange sections extending from the top of the turbine room roof to the turbine room floor level. In order to do this it is necessary to shore up the boiler-room trusses and shorten them 16 in. The boiler-room and turbine-room trusses will be framed to the columns in such a way as to develop the necessary moment value at these points. In the west wall of the boiler room new columns will be introduced extending from the tops of the trusses to the top of the foundation wall to which they will be securely anchored. The trusses will be framed into these columns.

Bracing will be added in the plane of the top chord of the boiler-room trusses and in the plane of the bottom chord of the turbine-room trusses throughout the building and some less general strengthening will be done. Because of the importance of stiffness and direct transfer of stress in this class of work, welded connections will be used with few exceptions. It is expected also that this will facilitate the construction work because of the great amount of field fitting which the conditions make necessary. Great care was exercised in working out the details and where concrete is cut or broken during construction the interrupted bars will be restored to full continuity by welded splices or by welding to the new structural steel.

It is believed that when this work is completed service in the San Diego Consolidated Gas and Electric Co. territory will not be seriously interrupted by any earthquake that is likely to occur there.

Series of Tours Planned Before Power Conference

A series of technical study tours have been planned to take delegates to the Third World Power Conference to various important industrial centers where the most recent developments in the production and application of electric power in this country may be seen. Tours have been arranged on five general subjects: (1) mineral sources of energy; (2) hydraulic sources of energy; (3) metropolitan areas, utilities and research; (4) railroad transport; and (5) major construction projects.

The tours begin either Aug. 27 or 31 and are scheduled to conclude in Washington either Sept. 5 or 6. The conference begins on Monday, Sept. 7. The tours will take visitors as far west as Chicago and as far south as Knoxville.

A 30-page bulletin giving details of the tour has been prepared, and is available from the director, Third World Power Conference, Interior Building, Washington, D. C.

River Problems in Lead at Portland Convention

Power plants and irrigation problems engage main interest of large gathering of American Society of Civil Engineers' western members—Highway problems and mosquito control also considered

IN HARMONY with the best traditions of the past the Portland, Ore., convention of the American Society of Civil Engineers, July 15 and 16, brought together a large and representative western attendance, some 500 in all. A strong program, centering on problems of stream development and water use but including also highway planning and mosquito control, held the attention of the members.

Grand Coulee, Bonneville and Fort Peck dominated an all-day technical session in which three divisions joined. Another session brought out an important paper on reclamation and preliminary data on the unusual irrigation problems existing west of the Cascades. Water supply, sanitation and stream protection and purification were discussed by the sanitary division, while the Oregon coast highway bridges and modern highway design in Washington and Oregon were subjects of a joint session of structural and highway divisions. Several excellent picture presentations of current large projects distinguished the technical sessions.

A distinctively new feature was provided by the program of the general session Wednesday afternoon, July 15, which was given over to a symposium on professional activities. Equally significant was the theme of the presidential address of Daniel W. Mead, who urged the need of formulating a comprehensive code of ethics for engineers.

With characteristic Northwestern enterprise the Portland local committee contributed to the social phase of the meeting by publishing an illustrated daily bulletin filled with personal notes about members in attendance, and by arranging an educational and entertaining series of inspection trips and scenic excursions. A group visit to the Bonneville power project, 40 miles east, formed the central feature of these trips.

Society affairs

IMPORTANT current matters of society business were considered by the board of direction in its sessions preceding the meeting of the society. Perhaps of greatest current interest was approval of the formation of a new technical division on Soil Mechanics and Foundations. Of related importance was preliminary action looking toward formation of a committee on flood-control questions. The formation of an inter-society joint committee on the history of engineering also was approved. The board voted to decline an invitation to join its name to a list of cooperative agencies in support of the federal government's proposed Conference on Upstream Engineering next September.

The board by vote expressed confidence in C. R. Olberg and Perry A. Welty, members, relative to charges that arose out of the Willacy County, Texas, irrigation project proposed two years ago as a PWA project. It considered some professional conduct cases and voted to expel one member.

The board discussed at some length the establishment of the grade of Student Member but took no action. Extended consideration of a proposal that every member be allocated to a local section also led to no present action.

Locations of 1937 meetings were determined as: San Antonio, Detroit and Boston for spring, summer and fall meetings respectively.

A call for a code

IN THE ANNUAL presidential address Daniel W. Mead urged the formulation of a code of ethics applicable to the whole membership of the society. After sketching the great change in economic and social conditions observable in recent years, he castigated first bad corporation practices and then government financing of power plants competing with private industry. He remarked that the doctrine of plenty needs only an adjustment in exchange, but pointed out that this problem is not yet solved. His call for a new code of ethics included the following statements:

> The code of ethics of the American Society of Civil Engineers and the codes of most other engineering societies apply most directly to the small percentage of engineers in general practice, and only remotely to the large majority of the membership. It seems highly desirable that a code of ethics and of conduct, perhaps advisory rather than mandatory, should be adopted which should be applicable to our entire membership.
>
> A code of ethics for the engineering profession is somewhat complicated by the fact that the profession contains many men who are not engaged exclusively in independent engineering practice nor employed by those in such practice; it includes also many engineers employed in public works as well as those who are officials of transportation, utility, manufacturing or construction corporations, or who are employed by such corporations. There are also engineers engaged in promotional and financial operations.
>
> It is the greatest hope of the speaker that by the careful preparation of such a code the opportunity will be available for all engineers to review frequently the ideals of their profession and improve their relationships with the public, with their fellow engineers and associates; that through the pressure of this society and its coordinate societies an understanding of these ideals shall be brought to every student of engineering; and that ultimately the ideals of honor, integrity and dependability shall predominate in all the relations of our great profession.

Professional activities

FOR THE FIRST time in years a full review of the society's activities in the professional field was presented, the entire general session on Wednesday afternoon being given over to this subject. Eight groups of activities were reported upon by committee chairmen or other representatives. Outstanding themes were registration, employment, and aims and activities; others included were salaries, fees, professional development (Engineers Council for Professional Development), national relations (American Engineering Council and Construction League of the United States) and public education (publicity).

James L. Ferebee, chief engineer of the Milwaukee Sewerage Commission and chairman of the committee on registration of engineers, summarized the growth of registration since the time of its first discussion before the society in 1901, and pointed out that the society's position has been contradictory inasmuch as it never endorsed registration until a year or two ago, although it had long worked toward it. Meantime registration progressed at the rate of roughly one state per year added to the registration area. Mr. Ferebee advocated the society extending assistance to the National Council of State Board of Engineering Examiners, to enable it to work actively for extension of registration through the remaining twelve states.

Engineering employment definitely foreshadowed the 1929 depression, according to a report on employment rendered by George T. Seabury, secretary. The placements made by the Engineering Societies Employment Service indicated the approach of unemployment as follows: at New York in July, 1928, at Chicago in April, 1929, at San Francisco in the fall of 1929; electrical engineers were first affected and mechanical engineers next while civil engineers after a short period of decreased employment reached an all time peak of employment (and of salary levels) near the end of 1930. Thence to October, 1932, however, about 35,000 civil engineers became

unemployed, and engineers in private practice saw their business shrink by 70 per cent.

Mr. Seabury recounted the work of the Employment Service in placing several thousand men since the end of 1932, of local sections in working for employment and financial support of unemployed civil engineers, beginning with the Professional Engineers Committee on Unemployment of the New York metropolitan section (which has placed nearly 10,000 engineers, two-thirds of them non-members), and the aggressive work of the society's directors and officers in working with government agencies to maintain engineering employment and continuance of public works. The first action taken in the latter direction followed the decision of the Investment Bankers Association, in 1932, to discontinue making municipal loans.

Study of the society's aims and activities was begun through a committee appointed two years ago and made permanent last January. The chairman of the committee, J. P. H. Perry, Turner Construction Co., New York, reviewed its principles and conclusions. Its objective is to outline a long-time program looking to the future of the society. It early decided upon expansion of society activities as a basic principle. It also recommended active stimulation of registration, correction of civil-service abuses, resumption of local section conferences, and appointment of a publicity expert. Among matters now under consideration are restudy of the committee structure of the society, establishment of broader relations with other professional groups, and the possibility of larger welfare and professional activities.

Discussion of the group of reports dealt mainly with the steady trend toward specialization of engineering societies, and the conflict between specialization and broader education in the engineering colleges.

Coast highway bridges

IN TWO PAPERS before the highway and structural divisions the design and construction of the five large new bridges on the Oregon Coast Highway were received by O. A. Chase, designing engineer, and G. S. Paxson acting bridge engineer of the state highway commission, Salem. The bridges are the Yaquina Bay bridge, with a 600-ft. steel arch; Alsea Bay, with a 210-ft. tied concrete arch in a series of three; Siuslaw River, with a bascule draw; Umpqua River, with a long swing span; and Coos Bay, with a steel cantilever of 793-ft. main span. All have continuous girder or rib arch approaches. Arch thrusts are in most cases taken by batter piles on 1:12 or 1:10 batter. Extra provision is made for wind; in the case of the large steel structures twice normal velocity was assumed and allowable unit stresses were taken as 28,000 for carbon steel and 39,000 for silicon steel. Descriptions of these noteworthy structures have been published in *ENR*, Nov. 14, 1935, p. 677.

As Mr. Chase pointed out, the differences in general design were due to the individual conditions of the different structures. The extensive use of concrete resulted from the desire to avoid so far as possible the bare steel structures in the direct sea exposure, where paint cannot be depended upon for more than two years. R. B. Wright, of the U. S. Bureau of Public Roads, Portland, in discussion, recalled that the original plan was to operate these bridges on tolls until repayment of the bonds, but the toll plan was abandoned. Traffic growth has been more than double that forecast.

The substructures of the bridges involved mainly cofferdam work, with piles in sand and underwater seals. Concrete superstructures were all built with the use of internal vibrators, which after this, their first use by the department, have been adopted as standard for all concrete bridge work; their use saved about ¾ sack of cement per cubic yard, and surface imperfections were noticeably absent. The large steel arch of the Yaquina Bay bridge was erected by cantilevering from the two ends with the use of cable holdbacks attached at the fourth and seventh panel points. The Coos Bay cantilever was erected by balancing cantilever and anchor arms over the pier with a steadying bent at the first panel point of the anchor arm and a landing bent two-thirds of the way to the rest pier. Mr. Paxson noted that, in skidding the derrick on channel skidways laid over the stringers, red lead proved unsatisfactory as lubricant and heavy cup grease had to be substituted.

Highway planning in the Northwest

A PAPER PRESENTED by R. H. Baldock chief engineer, Oregon State Highway Commission, "Highway Design as Applied in Oregon," stressed the importance of planning highway systems on a long-distance view and pointed out the risk of neglecting major problems while concentrating on proportioning aggregate, controlling water-cement ratio, determining the bearing value of soils, etc. Highway obsolescence should be combated. Oregon main highways are designed for speeds of 100 m.p.h. not because such speeds are recommended but to provide a safety margin in planning as well as in operation.

Oregon highway design is based upon wet pavement conditions (not snow and ice) because pavements are wet a large part of the time. For wet pavement the straight skid coefficient of friction is taken as 0.5; one-half second is allowed for driver reaction. Vertical curves are more hazardous than horizontal curves. Drivers who are well aware of the dangers of horizontal curves often are taken unawares when rounding the top of a vertical curve. Sight distances for vertical curves should be at least twice the stopping distance for the designed speed; Oregon standards call for a sight distance of 1,200 ft. on arterial highways.

In the course of active discussion of Oregon and Washington highway practice following Mr. Baldock's paper and a companion paper by Lacey V. Murrow, Washington State Highway Engineer, Olympia, it was brought out that a 4-ft. neutral strip between opposing traffic directions is standard in both states (originally Washington practice) on four-lane trunks; it is sometimes paved, but preferably is left rough to prevent cross traffic, which latter is dangerous. Deep ballast for all classes of roads has been made standard in both states. As to grades, Oregon investigations, Mr. Baldock reported, showed no increase in gas consumption between a level stretch and a stretch with equal rise and fall, so long as both were covered in the same gear and at the same speed.

Reclamation and land use

UNDER THE TITLE "Relation of Reclamation of Arid Land by Irrigation to the National Land Use Program," John W. Haw, director of agricultural development of the Northern Pacific Ry., St. Paul, presented a comprehensive analysis of the agricultural surplus situation and the importance of reclamation to adequate development of the West and a balanced agricultural and industrial economy of the nation. He referred to the growing opposition to further reclamation development, and to the almost accomplished introduction into the platforms of both political parties of planks opposing continued reclamation "while a surplus of farm products exists."

Because the West is isolated by its 1,000-mi. separation from the chief industrial and farming areas, it is subject to high transportation charges, and imports wheat and corn from abroad over a high duty barrier in preference to taking Midwest corn. Accordingly, regional self-sufficiency must be aimed at. "The West must not be allowed to drift into the situation of a vassal section of this country." But while producing staples for its own supply the West will always make its chief business the production of specialty food supplies for the East.

Further, increase in western population, estimated as ½ to ¾ million in the past five years, requires 1,200,000 to 1,800,000 acres of additional crop lands, against an actual decrease of 4,000,000 acres. Proper use of range lands which require a background of irrigated agriculture as winter haven, and due provision for the extensive population shifts certain to result from overdevelopment of the Great Plains, require active continuation of reclamation work. "The chances are that yearly for the next 20 years 2,000 to 3,000 farm families must be absorbed in some area," Mr. Haw added.

Ross K. Tiffany, executive officer of the Washington State Planning Council, Olympia, strongly endorsed Mr. Haw's views and conclusions. Citing figures

from the Yakima valley he argued that reclamation development pays both in return of cost and in the creation of new wealth. Further support was offered by Roy F. Bessey, consultant of the Pacific Northwest Regional Planning Commission, Portland. The Pacific Northwest, with large prospective industrial development due to its having 40 per cent of the country's potential water power, is likely to need a new farm population of some 100,000 families in the next generation or so. But, he agreed with the author, increased attention to the economic and social problem of reclamation is essential.

The Bonneville project

GENERAL features of the Bonneville project were described by C. I. Grimm, head engineer, north Pacific Division, U. S. Engineer Department, Portland. Major elements of the project are spillway dam fishways, powerhouse and navigation lock; the estimated cost was given as $45,000,000.

B. E. Torpen, construction engineer, presented some of the construction features and discussed special problems involved. For example, sounding the river channel for the cofferdam cribs was difficult, he said, because of the swift current and the very irregular bottom. A 32x80-ft. steel barge with two three-drum hoists was equipped with four sounding rods 4 ft. on centers. The rods were 3-in. extra heavy pipe housed in 6-in. extra heavy pipe, the latter extending to within 10 ft. of the bottom. With this rig a crew of 10 men in eight hours could take 800 soundings 2 ft. apart, to tenths of a foot.

Temperature readings in three blocks of the dam on which records have been made thus far show an average rise of 20 to 35 deg. F., reaching the maximum in five to fifteen days depending upon depth of cover. In setting guide columns for the spillway gates specification tolerances required accuracies of ½ in. After the guides are located accurately they are secured by welding to dowels (previously set in the concrete for this purpose) until permanently grouted in.

Grand Coulee and Fort Peck

GRAND COULEE DAM construction was outlined in an interesting illustrated presentation by C. D. Riddle, chief engineer of the MWAK Company, contractors, Mason City, Wash. All dam foundation work in the west cofferdam will be completed by the end of July; 7,000 cu.yd. of concrete is now going in daily, ¾ million yards having already been placed. This work is going on behind a cofferdam strong enough to withstand 110 ft. head, built in 90 days. Including the east cofferdam and river closure section, the contract for the foundation of the high dam involves a total of 4¼ million yards of concrete, which is expected to be in place by the end of 1937. The interesting mechanical combination of gravel and sand washing plant, belt conveyor to stock piles a mile away, suspension bridge conveyor to the west mix plant 3,500 ft. from the stockpiles, and pipe line for pumping cement from the unloading point 6,200 ft. to the farther mixing plant, was fully described and illustrated.

Construction of radically different type, the enormous hydraulic-fill placing of the Fort Peck dam in northeastern Montana, was similarly presented by description and views by Lt.-Col. Thomas B. Larkin, district engineer, U. S. Army, Fort Peck. The 100,000,000 cu.yd. of earth required for this strucure make it by far the largest earth dam in the world. Hydraulic-fill placement in the dam (9,000 ft. length, 2,850 ft. width, 242 ft. maximum height) and in the 11,500-ft. length of dike on the left bank is being done by four 28-in. dredge units, each equipped with 12,500-hp. pump power including boosters (see p. 105, this issue). By the first of June of the current year, 27,500,000 cu.yd. were in place in the two halves of the dam separated by the river gap. It is expected that the diversion tunnels will be completed in 1937 and the river diverted through them, after which the closure section will be placed. Completion is expected by 1939.

Col. Larkin, in speaking of the Fort Peck core formation, reported that the upper part of the core shows an increase in percentage of coarse material during the first few weeks, presumably by downward migration of silt and sand through the clay. Below this, increase in density of the core is purely consolidation by squeezing out of water, according to T. A. Middlebrooks, associate engineer. Mr. Middlebrooks also stated that close check is kept on the banks or shell of the dam in order to insure stability and impermeability.

Columbia River improvement

IN A PAPER on "Improvement of the Columbia River for Navigation," Col. Thomas M. Robins, Corps of Engineers, outlined channel conditions and traffic possibilities in the tidal and nontidal sections of this stream. Tidal effects extend 140 mi. up the river to the Bonneville dam and the completion of this project will provide a channel depth of more than 30 ft. to The Dalles, which is 190 miles from the ocean. For 100 mi. from the mouth (as far as Vancouver, Wash.) the river channel has been maintained 35 ft. deep and 500 ft. wide. The proposed 27x300-ft. channel from Vancouver to Bonneville, recently recommended by the War Department, would make it possible for 85 per cent of the ocean-going vessels now entering the Columbia River to pass through the navigation lock at Bonneville and go on up the river as far as The Dalles.

On the lower river ocean-going commerce exceeds 6,000,000 tons yearly, and 2,000,000 tons is carried [illegible] river vessels; there is also about 4 [illegible] tons in rafted logs. On the nont[illegible] section regular boat service, long [illegible] continued, was resumed in 1933 [illegible] now amounts to 85,000 tons per year. The reasonably prospective commerce for a ship channel from Vancouver [illegible] The Dalles is estimated at 2,300,000 [illegible] per year and the saving at 40c. per [illegible].

Model studies

IN A PAPER on "Hydraulic Models as an Aid in Design and Construction" J. C. Stevens, consulting engineer, Portland, described model work at the Bonneville hydraulic laboratory which saved more than ten times its cost and expedited completion of the project. Every stage in the unwatering program was modeled. Scales ranged from 1:5 to 1:100. The model tests correctly indicated results in the prototype with an accuracy well within all practical requirements. Studies included the sequence of placing cribs, methods of closure, size of riprap required, scour and fill to be expected from cofferdam overtopping, and size and location of spillway apron baffles. Tests on 1:5 models of spillway gates showed that certain conditions would cause cavitation and attendant vibration so violent as to menace the safety of the gate; proper aeration holes eliminated the vibration. Flowage costs and flood damages were reduced greatly by a 1:100 model test of the river bed above the dam which showed that certain channel improvements could compensate for raising water at the dam.

Model studies no less elaborate, carried out by the Bureau of Reclamation for the design of the Grand Coulee dam, were described by J. E. Warnock, hydraulic research engineer of the bureau, Denver. The chief problem was the design of the spillway overfall and the means of energy absorption at the toe of the overfall, where at maximum flood (1,000,000 sec.-ft. at head of 2[illegible] ft. on a spillway length of 1,650 ft.) a total of 31,800,000 hp. must be dissipated, which amounts to 19,300 hp. per foot of spillway length. Successively spillway models were built to scales of 1:1.84, 1:40 (with glass side panels), 1:15, and finally 1:120, the latter model including dam, powerhouses, tailraces and a half-mile length of river bed downstream. The earlier sets of tests showed the proper solution to be a curved trough or "bucket" of 50-ft. radius and with 1:1 upslope toward tailwater. A dentated lip was at first included but it was found to develop objectionable vacuum conditions around the teeth of the lip and created the possibility of much damage from ice and logs, so that the teeth were finally eliminated. Erosion of the bed below the dam was found to be well controlled by the adopted design. Within the bucket the water velocities at half the extreme flow, or 500,000 sec.-ft. ranged from 13[illegible] ft.

per sec. at the entrance of the sheet into the pool (against calculated velocity 141 ft. per sec.) to 55 ft. per sec. at the point of discharge. An oscillatory transverse wave in the bucket, whose occurrence in the shelter models led to building the full model at 1:120 scale, was found to be controllable by increasing the tail-water depth.

The spillway crest and drum gates were similarly studied as to form. Later model studies dealt with the river diversion, which is to be accomplished by carrying the water through gaps left in the concrete of the first-completed west section.

Model experiments made in connection with the Fort Peck project were reviewed by Gail A. Hathaway, senior engineer, U. S. Engineer Department, Kansas City. The spillway was tested in model scales of 1:36 and 1:25, the latter including a downstream portion to observe erosion. Objectives were hydraulic efficiency of the spillway and energy dissipation provision at the end of the spillway paving. It was important to reduce turbulence below the spillway gates, as high wave action would require increased freeboard of the sidewalls and therefore greater expense. Vanes 230 ft. long below the gates gave satisfactory flow conditions.

A 1:52 model of one diversion tunnel was built to study flow under various conditions of gate operation and to determine head loss of the gate. It was found that air vents were needed downstream from the emergency gate openings to relieve negative pressure at part opening. A 1:70 model of the outlet apron of the four tunnels and models of the main dam were also studied.

Irrigation west of the Cascades

GEORGE E. GOODWIN, senior engineer, U. S. Engineer Department, Eugene, Ore., described the general results of cooperative studies by the army engineers and the state of Oregon of the possibilities of developing irrigation storage in the Willamette Valley lying west of the Cascades in Oregon, as part of stream development for flood control, navigation improvement, power and irrigation. Summer rainfall in the valley is too low for best crop production; increase of yield by 50 per cent under irrigation has been demonstrated in long-time tests, but irrigation can be provided only through storage and gravity canal supply. If part of the cost were covered by flood-control benefits and part by power revenue, the irrigation development would be feasible, Mr. Goodwin indicated.

Presenting fuller data on the study, Lt.-Col. Milo P. Fox, district engineer of the First Portland District, pointed out that under the rainfall conditions in the Willamette drainage area, where high precipitation occurs in winter and low in summer, flood-control use of reservoirs does not conflict with irrigation use or with storage for power and navigation. The high elevation of storage gives ample power opportunity, and as the streams are free from silt the reservoirs will be permanent. A full development of storage possibilities will double the low streamflow, produce a quarter million kilowatts of power, reduce pollution troubles, and irrigate the major part of the valley.

C. E. Stricklin, state engineer of Oregon, Salem, emphasized the need of Willamette storage if any new irrigation area is to be developed in the valley. M. R. Lewis, U. S. Department of Agriculture, Corvallis, Ore., further supported the argument citing the experience in the Rogue River valley, where irrigation progressively established itself as necessary to successful production. Washington conditions were dealt with by C. J. Bartholet, state supervisor of hydraulics, Olympia. West of the Cascades in that state irrigation "will probably for some time be confined largely to small individual enterprises, especially since storage is not necessary."

VARIOUS PROBLEMS of water-supply protection of Portland, both in the forest reserve from which the supply is obtained and in the distribution system, were summarized by Ben S. Morrow, chief engineer and general manager of the city's water bureau. These included camp sanitation on dam construction at Bull Run lake in 1928 to 1929 and sanitation of a 200-man CCC camp on the headwaters during the last three years; chlorination of the supply since 1928 and the addition of ammonia since 1932 (½ lb. ammonia to 2 lb. chlorine per m.g.) as a safeguard against possible pollution of the water from any source above the diversion; and within the city, protection of reservoirs and industrial services.

The reservoirs are protected from pollution by seagulls by a device first used by the Spring Valley Water Co. of San Francisco, namely stretching wires a few feet above the water surface at such spacing that the birds could not take off without flying into the wires. Protection against cross-connections, Mr. Morrow said, "requires constant inspection to keep some enterprising plant engineer from putting in a cross-connection for ease of operation." Where it is necessary to have both supplies available for common use, the city requires that an elevated tank be installed and the potable supply discharged into the tank over the top at a level high enough to prevent siphoning back.

Much more extensive sewerage and other protective work of railway and logging camps and of small communities was necessary in the Green River watershed, from which Tacoma, Wash., obtains its chief supply, according to W. A. Kunigk, water superintendent of Tacoma. An inspector deputized by the state health department, maintained at the headworks, makes periodic bacteriological tests. Railroad bridges and trains are subjected to special protective requirements.

Details of sewage-treatment conditions in Oregon were given by Carl E. Green, state sanitary engineer. All the plants built to date use biological processes; no chemical plants have been built or are planned. Three activated-sludge plants are under construction or completed, all within the last year. Rotary distributors are used on trickling filters in all but the earliest plants. No power use of sludge digestion gas has yet been provided for. At Pendleton a separate sludge digester has recently been added to an Imhoff tank in order to give increased storage capacity.

Industrial wastes play the chief part in the serious pollution of the Willamette River, as brought out in a paper by Prof. F. Merryfield, Oregon State College, Corvallis. Flax retting, fruit packing, paper and pulp plants and the like below Salem cause the river to be practically depleted of oxygen when it reaches Portland. Much domestic sewage adds to the load, and Portland contributes its 300,000 population discharge. Studies to cope with the industrial pollution have begun, but Prof. Merryfield indicated that much remains to be done to remove the pollution.

R. E. Koon, consulting engineer, Portland, presented a review of stream pollution work in Oregon, where 71 per cent of the population is concentrated in the Willamette valley, which includes only 12 per cent of the area of the state. As the cities are small and scattered, the population served by adequate sewage treatment plants is only 66,000 while facilities should be provided for a population of 530,000. Thirteen plants exist, the first built in 1925; no less than nine were put into service in 1936.

Santa Fe Builds New Rail Line

THE FIRST large piece of new railway line construction to be undertaken in this country in some years was begun in April by the Atchison, Topeka & Santa Fe Ry. The new line runs from Boise City, Okla., to Las Animas, Colo., a distance of 111 miles. It is a continuation of a line begun in 1930. As described in the May issue of the *Engineers' Bulletin* of the Colorado Society of Engineers, the completed line extends from Amarillo, Texas, to Boise City, Okla. When the section now under construction is completed, it will form the final link in a north-south railroad connecting Denver with Galveston on the Gulf of Mexico. It will reduce the distance over the Santa Fe line between Pueblo and Amarillo from 550 miles to 320 miles. The distance over the Burlington line between these two points now is 347 miles.

CURRENT NOTES ON SEWAGE DISPOSAL

An analytical summary of recent developments conducted by

WILLEM RUDOLFS
Chief, N. J. Sewage Experiment Station
New Brunswick, N. J.

● DIGESTION TANK CAPACITY

It is well known that a good deal of difficulty occurs when the capacity of sludge digestion tanks are too small. For instance, when there is insufficient digestion capacity gas production is greatly curtailed. While increased temperature is an important factor in speeding up the digestion process, heat cannot be applied economically to two-story digestion tanks at present. It is conceivable, however, that with sufficient digestion capacity available, gas production would approach that of separate sludge digestion tanks. Data on gas production from two-story tanks with extremely large digestion capacities are scarce, if available at all. The figures presented by Keppner (*Gesundheits Ingenieur*, Mar. 21, 1936) on the two-story tanks at Munich, having sludge digestion capacities of 1,200 cu. ft. per capita, are therefore of interest when compared with the results from an average heated separate sludge digestion tank.

	Munich Two-Story Tank	Heated Separate Digestion Tank
Capacity cu.ft./capita	1200	2.5
Cu.ft. gas/capita/day	.51	.75
B.t.u./capita/day	312	528
Temp. Deg. F.	52	80

Calculations indicate that the destruction of organic material varied at Munich during the years 1931-34 from 43.5 to 63.8 per cent. Apparently this provision of enormously large tanks, where the digestion capacity is 500 times greater than that used in American practice for heated separate digestion tanks, is not sufficient to produce equal quantities of gas per connected person—in other words increased digestion capacity can not compete with the advantages of tank heating.

● MEASURING OXYGEN ABSORPTION

In the operation of activated-sludge plants, it is important to know the status of certain biological conditions in the plant. To facilitate operation, it should be possible to determine promptly several factors, among which are: the immediate free oxygen requirements of the sewage-sludge mixture, the sewage load on the plant, the coagulation activity of the sludge and the stage of oxidation of the sludge. These factors, in turn, affect the time required for, and the degree of, purification. Kessler and Nichols (*Sewage Works Journal*, September, 1935), believe that they have developed a chemical method or technique for the determination of the rate of utilization of oxygen by a mixture of raw sewage and activated sludge for any period of time during the treatment process after the sewage is mixed with the returned sludge and the aeration process has started. The method is based essentially on noting the dissolved oxygen depletion in sewage-sludge mixtures over short periods of time and provides a means for converting the results to parts per million per hour.

● HIGH- AND LOW-TEMPERATURE DIGESTION

Attention has been called previously (*ENR*, Dec. 26, 1935, p. 890) to the possibility of reducing the digestion time of sewage sludge by subjecting the mass to consecutive periods of high and low temperature digestion. These results dealt with fresh solids. Following a series of semi-plant experiments on the digestion of mixtures of activated sludge and 15 per cent by volume of fresh solids, the practical application was discussed by Ardern and Lockett (*Proc.*, Institute Sewage Purification, 1935, 193). At the low temperatures (76-84 deg. F.) the sludge was detained in the heated tank for 10 days, followed by digestion at atmospheric temperature for 10 to 21 days; 1.81 cu.ft. of gas was produced per gallon of sludge, and there was a sludge volume reduction of 54 per cent. Corresponding figures for high-temperature digestion (122-130 deg. F.) were: detention in the heated tank for 5.2 days, followed by 4 to 7 days' digestion at atmospheric temperature; gas production amounted to 1.57 cu.ft. per gallon sludge, and the digested sludge had a volume of only 44 per cent of the original quantity. It is concluded, therefore, that high-temperature digestion permits the use of smaller tank capacities, and a smaller volume of sludge for ultimate disposal is produced. However, the quantities of gas produced are less. It becomes, therefore, a problem of economics to decide which type of two-stage digestion should be adapted at a given place. Low-temperature digestion has been installed at Manchester for the Davyhulme Works, with the possibility of future adoption of high-temperature digestion.

● ACID PIPE CLEANING DANGEROUS

The danger of poisonous gases produced in the decomposition of organic matter must not be overlooked, and laborers should be frequently cautioned to take appropriate protective measures. Hydrogen sulphide is not the only toxic vapor to be taken into consideration. Kremer (*Gesundheits Ingenieur*, Jan. 11, 1936) reports the death of three men killed while cleaning clogged water pipe lines in a large industrial establishment.

The pipe was filled with a mixture of hydrochloric acid and a protective colloid (tar) and left standing for 24 hours. When a laborer started to drain the pipe in the bottom of a pit he suddenly toppled over, and two men attempting to rescue the man descended into the pit and were also killed. The probable cause of death was asphyxiation from carbon-dioxide which was produced in large quantities and displaced the air near the bottom of the pit. It is possible too that some sulphur compounds were released either from the pipe or from the decomposition of organic material lying in the bottom of the pit.

● DIGESTION TANK HEATING

The practical question dealing with the location of heating coils in digestors to obtain the maximum heat exchange and minimum heat loss has been discussed since the advent of heated tanks. Theoretical considerations lead to the conclusion that heating coils should be placed as near as possible to the zone of active digestion. Laboratory and plant experiments indicated that these contentions were correct, but no data has been available to show what the actual differences amounted to from a practical point of view.

Calculations from operating results obtained in the use of a digestion tank with heating coils at the bottom and another with center coils located about two-thirds below the sludge level on the sides of the tank, were made by Muller (*Gesundheits Ingenieur*, May 14, 1936). His work shows that coils placed at the bottom of the tank were only 58 per cent as efficient as coils of equal capacity attached to the side walls. The sludge used in these studies flows well, so that with denser sludge it is possible that the difference would be still greater.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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Making Better Concrete

PLAIN CONCRETE—By Edward E. Bauer. Second Edition. Cloth; 6x9 in.; pp. 364; photographs, drawings and tables. Published by McGraw-Hill Book Co., Inc., New York and London. Price $4.

SUCH SIGNIFICANT CHANGES in concrete making technique have occurred since 1928, that this new edition of Prof. Bauer's book should prove very useful. The chapter on special cements has been enlarged to include the new knowledge of the setting and hardening actions of cement. New curves for present-day cements show the relationship between strength and (a) water-cement ratio; (b) cement-space ratio and (c) cement-water ratio. Low temperature effects are outlined, workability and vibration are covered in more detail. All the A.S.T.M. specifications have been brought up to date.

Progress in Housing

HOUSING OFFICIALS YEARBOOK—1936—Edited by Coleman Woodbury. Cloth; 6x9 in.; pp. 244. Published by the National Association of Housing Officials, 850 East 58th St., Chicago, Ill. Price $2.

HOUSING DURING 1935 is covered in detail in the second Housing Officials Yearbook. Some 60 contributors have furnished chapters which have been assembled into a reference book on public housing activities by Coleman Woodbury, director of the association. The subjects covered include federal, state and regional housing agencies, unofficial agencies, current housing problems and housing in England.

An Engineer on Economics

PLATFORM FOR AMERICA—By Ralph E. Flanders. Cloth; 5½x8 in.; pp. 118. Published by Whittlesey House, McGraw-Hill Book Co., New York. Price $1.00.

RALPH FLANDERS has long been a student of economics; further, as a member of the Industrial Advisory Board he had an unusual opportunity to study the economic theories of the National Recovery Administration. Thus he is especially well qualified to comment on our present situation and to suggest the way in which the nation should lay out its future course. Mr. Flanders finds some good but a lot that is undesirable in the present efforts to reshape our economic system. These efforts he takes up point by point, discussing each clearly and concisely. Finally, he sets down what he believes should be the platform for each major element of the nation; business, agriculture, labor, banking and finance, and government. The book is short, remarkably well thought out and well written. It should be read by every citizen who feels the need for a clear statement concerning a complicated problem.

China's Problems

Reviewed by Arthur M. Shaw
Consulting Engineer, New Orleans, La.

HYDRAULIC AND ROAD PROBLEMS IN CHINA—By a committee of experts serving under the direction of the "Communications and Transit Organization" of the League of Nations. League of Nations publication No. C.91.M.34.1936. VIII. Paper; 8x10½; pp. 213. Available in the U. S. A. from World Peace Foundation, 8 West 40th St., New York and 40 Mt. Vernon St., Boston.

THAT the studies required of the committee of experts that prepared this report were many and diverse is evidenced by the following list of subjects covered by the report: The Yellow River; Other Rivers in North China; The Yangtse and Hwai Rivers; The Road Problem; Irrigation Projects in North China.

Of perhaps the greatest interest to American engineers is the material regarding the Yellow River, its characteristics, floods and control methods—past and recommended.

As has been done by every other modern engineer of experience who has studied and reported on the Yellow River, the committee found it necessary to preface its report with many reservations, these being considered necessary on account of the extreme paucity of scientific data and the entire absence of essential records extending over any considerable period of time. The following quotation from the report will give something of an idea of the complexity of any approach which may be made toward the control of "China's Sorrow":

> Further and more particularly, Chinese rivers present special phenomena, not observed on Western rivers, which may make the current rules of river hydraulics inapplicable to the Hwang Ho and other Chinese rivers.
>
> The problem lies not so much in the volume of water discharged as in the immense amount of solid matter, consisting mainly of loess, carried down by the flood waters of the tributaries, and of the main river, on a quite exceptional scale, and particularly in the peculiar way in which the loess, attaining on some tributaries as much as 50 per cent in weight, is carried along and deposited, as a result of the changes in speed and the action on friable soil and earthworks of water so heavily laden with solid matter.

In connection with the silt loads carried by the Yellow River and its tributaries, the committee has brought out and apparently confirmed an interesting point which the writer does not recall having seen stressed by previous writers, either American, German or Chinese. This is the relatively small amount of silt carried by the upper portion of the Yellow River, as compared to its main tributary, the Wei Ho which joins the Yellow only about 200 mi. above the apex of the delta cone. All modern authorities are agreed that it is the tremendous silt load which places the problem of the Yellow River in a class by itself.

While it has made generous reservations regarding data and conclusions, the committee does not seem to have hesitated to discuss certain controversial points and to arrive at conclusions quite at varience with those of other engineers who presumably had at least equal opportunities for observation and study. As the writer now recalls, the late John R. Freeman suggested a more regular spacing of the primary levees on each side of the Yellow River, placing them at a sufficient distance apart to carry the normal flow of the river and the minor floods and serving, with auxiliary works, to restrain the river so far as practicable. As a result of such restraint, it was planned that the river would have an increased ability to keep its proper channel scoured out to a greater degree than at present. All earlier students appear to be agreed on the necessity of an additional set of levees, to serve both as a second line of defense and to afford emergency storage for excessive floods. The idea of attempting to force the river to maintain its channel in better condition appears to have been summarily dismissed by this committee without convincing reason.

It is interesting to note that neither the present authors, nor any of their predecessors among foreign hydraulic engineers, have visited the present mouth of the Yellow River. Mr. Freeman desired to do so but was prevented by an armed disturbance in that section.

In the section devoted to various irrigation projects, the committee very properly lays great stress on the design, control and maintenance of auxiliary works, especially those at the river intake. In their nature the problems presented at the intakes from the rivers of China are similar to those of other silt-bearing streams, but in degree they differ widely. In other matters however, much of the constructive value of suggestions, consisting largely of criticisms of existing works, appears to be lost. Conclusions are reached which obviously are based on inaccurate or incomplete information and frequently they

appear to fail in an appreciation of Chinese farming economy. In illustration of the latter point, the Saratsi Irrigation Project, in Southern Suiyuan was condemned in its entirety as being technically impractical as designed and economically unwarranted even if properly designed. This project, long considered a necessity for the relief of famines which occur every few years, was started in 1929, pushed through to partial completion under feverish haste to meet a great emergency and the Yellow River waters were turned into the canals without proper supervision, or precautions to prevent injury to the partially completed works. As designed, the plans include some details which undoubtedly should be modified as time and funds permit and the operation of the system should be controlled by experienced officials empowered to act in the interests of all the area to be served; but that the project should be abandoned and the residents of the section be compelled to migrate to other and perhaps even less favored areas or die of starvation, appeals neither to the Chinese engineers of wide experience who did the original work, nor to the American engineers and philanthropists who aided in the completion of the plans and in the early construction work. One entire system of laterals was utterly condemned for no apparent reason other than that, during low stages of the Yellow River, the water level in these laterals would be from one to two feet below the level of the adjacent fields. Raising of irrigation water by the individual farmers might not have appeared as an insurmountable difficulty had the committee been fully familiar with agricultural methods of Central and Southern China where it is usual practice to lift water to even much greater heights, for rice irrigation.

With the crops grown in Suiyuan, a fraction of the water required for rice, applied at the right time, will often make the difference between starvation of thousands of people and at least a reasonable subsistence. With the dry-farming methods employed, a sustaining crop can be raised if showers occur at planting time and a total of 15 in. of rainfall occurs during the year; but in 1928, the rainfall amounted to only 6 in. and in the years 1925, 1926 and 1930 there was a total for each year of less than 10 in. Famine conditions occurred during each of these years, the one in 1928 resulting in the deaths of thousands of the inhabitants. It was to meet such a situation that the Chinese authorities, aided by Western philanthropists, decided that an irrigation system, admittedly not ideal, should be built.

With the inexhaustible waters of the Yellow River immediately at hand, it is the writer's opinion that the starving millions of North China will find it possible to place that water on their parched fields during the years of deficiency in rainfall.

Miscellaneous Notes and Booklets and Reprints

METHODS OF MEASURING ability to drive an automobile—Bulletin 115, Engineering Extension Service, Iowa State College, Ames, Iowa.

DISTRIBUTION OF SHEARING STRESSES in concrete floor slabs under concentrated load, Bulletin 126, Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa. Free.

SOIL SURVEYS FOR HIGHWAYS, a review of present practices and a brief history, Engineering Experiment Station, Circular No. 33, Ohio State University, Columbus, Ohio. Free.

DEFICIENCIES IN PRESENT WATER RESOURCE INFORMATION is the subject of publication No. 3 of the College of Engineering, New York University. The paper is by Thorndike Saville.

THE HISTORY AND USES OF ASPHALT is the subject of a pamphlet entitled "Asphalt, Nature's Most Versatile Product," published by the Asphalt Institute, 801 Second Ave., New York, N. Y.

SIGNALLING FOR HIGH-SPEED TRAIN OPERATION, a paper before the American Association of Railroad Superintendents, has been published in pamphlet form by the author, Burt T. Anderson, 347 Madison Ave., New York City.

DRAINAGE POLICY AND PROJECTS, a report of the special subcommittee of the Water Resources Committee, National Resources Committee, has been prepared in mimeographed form and may be obtained from the committee headquarters in Washington.

THE COLORADO DELTA, a discussion of the Spanish explorations and maps Colorado River silt load and its seismic effect on the Southwest, by Charles Kirby Fox, consulting engineer, Washington Building, Los Angeles, Cal., has been published by Mr. Fox in mimeographed form.

THE SAN FRANCISCO TERMITE SURVEY is the subject of a progress report by A. A. Brown. The report is published by the Department of Public Works of San Francisco, the department under which the survey is being conducted. It emphasizes the need for a re-study of building codes as a necessary step in reducing the damage caused by termites.

NATIONAL RESOURCES COMMITTEE REPORTS on regional planning are beginning to appear in printed form. The first to be published are Part 1—Pacific Northwest—dealing primarily with the Columbia River basin; and Part 2—St. Louis Region. Copies may be obtained from the Superintendent of Documents, Washington, D. C., for 50 cents and 25 cents, respectively, in paper covers. The National Resources Committee also has recently submitted to the President a progress report with statements of the coordinating committees. Copies of this also may be obtained from the Superintendent of Doceuments for 25 cents.

THE NEW YORK STATE FLOOD of July 1935, is described in Water Supply Paper 773-E of the U. S. Geological Survey. Copies are obtainable from the Superintendent of Documents, Washington, D. C., price 15 cents.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

A DIRECTORY OF ORGANIZATIONS IN THE FIELD OF PUBLIC ADMINISTRATION 1936—Paper; 6½x9½ in.; pp. 179; classified section. Published by Public Administration Clearing House, 850 E. 58th St., Chicago, Ill. Price $1.00.

ANALYSIS AND DESIGN OF STEEL STRUCTURES—By Almon H. Fuller and Frank Kerekes. Cloth; 6x9 in.; pp. 627; photographs, linecuts, tables. Published by D. Van Nostrand Co., Inc., New York. Price $5.00.

A PIONEER SOUTHERN RAILROAD—By Thomas D. Clark. Cloth; 5x7 in.; pp. 171; linecuts, tables. Published by University of North Carolina Press, Chapel Hill, N. C. Price $2.00.

58TH ANNUAL REPORT OF THE DEPARTMENT OF HEALTH OF THE STATE OF NEW JERSEY, 1935.—J. Lynn Mahaffey, M.D., Director. Cloth; 6x9 in.; pp. 410; tables and charts. Published by MacCrellish & Quigley Co., Trenton, N. J.

CONSTRUCTION COSTS—"The Construction Industry Year Book"—9th edition. Paper; 9x12 in.; pp. 128; charts and tables. Published by Engineering News-Record, 330 W. 42nd Street, New York. Price $2.00.

ENGINEERING QUESTIONS AND ANSWERS—Vol. I.—"Questions and Answers" section of the *Mechanical World* Board; 7x10 in.; pp. 176; tables and linecuts. Published by Emmott & Co., Ltd., London. Price 6s.

SILT THEORY OF FLOW OF WATER—By Radha Krishna Khanna. Paper; 6½ x9½ in.; pp. 50; tables. Published by the author, Rajar, District Gujrat, India.

THE EVOLVING HOUSE—III—RATIONAL DESIGN—By Albert Farwell Bemis. Cloth; 6x9; pp. 625; Linecuts, tables. Published by Technology Press, Massachusetts Institute of Technology, Cambridge, Mass. . . . *The concluding volume of the series.*

THEORY OF ELASTIC STABILITY—By S. Timoshenko. Cloth; pp. 518; 6x9 in.; photographs, linecuts and tables. An Engineering Societies Monograph; published by McGraw-Hill Book Co., Inc., New York. Price $6.00.

TRANSIT ENGINEERING—PRINCIPLES AND PRACTICE—By John K. Tuthill. Board; 8x11 in.; pp. 334; photographs, linecuts, tables. Published by John S. Swift Co., Inc., St. Louis, Chicago, New York. Price $4.50

VOCABULARIO TECNICO—Spanish-English, English-Spanish—By L. A. Robb. Cloth; 6x9 in.; photographs, tables; pp. 119. Privately printed at the Princeton University Press, Princeton, N. J. . . . *A vocabulary of terms used in engineering and construction translated from Spanish into English and from English to Spanish, prepared originally for the staff of the Ambursen Dam Co., New York.*

Letters to the Editor

Continuity in Building Frames

Sir—A scholarly monograph, "Continuity in Concrete Building Frames," dated December, 1935 and sponsored by the Portland Cement Association is worthy of study. The subtitle of the 60-page booklet is, "Practical Analysis for Vertical Load and Wind Pressure." The contents apply to continuous steel building frames as well as those of concrete. The monograph is in accordance with the latest thought on the subject. How "practical" it will be to an engineer called upon to design the steel frame of a many-storied building will depend upon the time at his command and his qualifications. For the specific case before him he may think the conventional methods sufficient.

The analysis presented for vertical load is the moment distribution method of Prof. Hardy Cross with slight modification. In this method it is necessary to know the values of K (the ratio of I/l for individual members) before an analysis can be made. From this the ratio of K-value of a column to K-value of a beam, and Q (the joint coefficient), are determined. In reviewing a frame already designed these are easily computed. When only loads, spans and story heights are given, the values of Q must be selected. A section of the monograph is entitled, "Selection of Q-Values When Cross-Sections Are Not Known."

Attention is called to the procedure recommended for determination of moments produced by live loads placed in short spans flanked by one or two long spans without live load. This case of loading is sometimes neglected. *The American Architect* in an article, "Structural Design Problems," May 10, 1922, mentions a school building in which trouble developed in the reinforced-concrete floor. The designer had used the specifications required in a near-by city and took for coefficient C, in the formula $M = \frac{wl^2}{C}$, a value of 10 for outer spans and of 12 for corridor spans. The condition during a recess period when the short spans of the corridor carried full live load and the long spans of the adjacent class rooms carried no live load had not been considered. This was diagnosed as the cause of the trouble. After the reinforcement over supports was cut in order to reduce the effect of continuity to the amount originally assumed by the designer no further trouble was reported.

The portion, "Wind Pressure," will be read carefully by those interested in high building construction. The author in the introduction states that the distribution of the wind load must be determined before the analysis can proceed and that the method of distribution is as important as the subsequent analysis. This is true, but the choice of intensity of wind pressure to be assumed affects results more than either methods of distribution or methods of analysis. The distribution of wind pressure to indiviual bents as presented by Albert Smith is favored. The analysis is based upon suggestions made in the slope-deflection method of Wilson and Maney. "It should be noted, however, that it is a source of error to ignore column extension, and the error may offset the accuracy of elaborate methods of analysis." As with the vertical load, K-values must be known or selected before the analyse can proceed.

Note will be taken of the section, "Convention and Use of Signs." Two sign conventions for moments, the author says, are available: (1) "a moment is positive when it sags the beam," and (2) "a moment exerted upon a beam is positive when it tends to rotate the joint in the clockwise direction." Convention (1) is recommended for design and convention (2) for analysis.

The derivation of essential formulas relating to continuity is given clearly and concisely in Appendix A (Vertical Load) and Appendix B (Wind Pressure). The 37 references in the bibliography are to books and articles easily available.

ROBINS FLEMING

New York City
May 26, 1936

Flood Control Policy

Sir: I was pleased to note in the June 4 issue of *ENR*, in its editorial entitled "A Flood Control Policy," a strong protest against the idea of saddling all flood control costs on the federal government. That form of paternalism violates every tenet of economic justice and tends to undermine the morale and the sense of financial responsibility of local governments. Although the formulation of a definite, federal flood control policy, in my judgment, should await the results of more extensive flood control surveys and investigations than have yet been made, there is one basic principle that should certainly be included in such a policy and, as far as practicable, it should also obtain for any interim legislation for specific projects.

That principle is that payment for flood control developments should be regarded as a specific responsibility of local, state and federal interests and that the cost allocation to these three agencies should be on the basis of benefits conferred. These will vary in degree for different projects and it should be recognized that, in specific cases, benefit assessments might be nil for one or the other of the agencies named or the assessments might justly fall entirely on one of them.

With continuing urban, suburban and rural developments along our water courses, and the concomitant tendency of these developments to encroach on the natural flood planes of these water courses, floods are a serious and a steadily increasing menace. They are more than a local problem because, for their correct solution, entire drainage basins must be dealt with and, frequently, these drainage basins not only transcend county and state lines but they also, in some cases, extend beyond our national boundary and thus inject an international phase to the problem. More and more, therefore, is flood control becoming a matter of national concern and it would seem that the time has arrived when the government should formally recognize it as being "affected with a federal interest," should carefully review the present negative policy concerning it, and should definitely undertake the formulation of a carefully considered, positive national flood control policy.

So many vital issues are involved in its political, technical and economic aspects as to suggest that any permanent legislation should be preceded by a very thorough analysis of all phases of the problem, this work to be under the direction of a commission of competent, technical personnel or it might be assigned to one of the existing federal agencies. This analysis should contemplate a nation-wide flood control survey which would embrace practically all important drainage basins in the country and it would, of course, assemble and coordinate the data afforded by all previous work along these lines that could be made available to it. It is anticipated that this survey might extend over a period of several years and that it might cost as much as $25,000,000.

Such a study would clearly indicate the magnitude and bearing of the problem; would provide information as to its important technical phases such as the magnitude and frequency of floods, the extent of desirable and available storage, the extent of desirable and available flood plane reserves, etc.; data as to actual and potential damages and the probable range in cost of corrective measures for various drainage basins throughout the country; and it would become the basis for subsequent national and local flood control advance planning. Unquestionably it would afford the basis for a more intelligent and practical federal flood control policy than would otherwise be possible. This program would expedite rather than delay the enactment of correct and adequate legislation in this important matter and it need not embarrass interim, temporary legislation deemed essential for specific projects requiring earlier attention.

JOSEPH JACOBS

Seattle, Wash.
June 16, 1936

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EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, N. A. Bowers, W. G. Bowman, W. W. DeBerard, C. S. Hill, H. W. Richardson, E. J. Cleary

Editorial and Publishing Offices at 330 West 42d Street, New York

July 23, 1936

Fort Peck Dam at Its Peak

FORT PECK DAM ranks as one of the great construction projects of all time. Construction operations without precedent have been developed to meet the requirements of a job of unprecedented magnitude. Never before has the engineering world seen four dredges pump close to a million yards of material a week into a fill; never before have 14,000,000 cu.yd. been excavated from a single cut for a spillway. Similarly, the spillway structures and the four diversion tunnels mark a new advance in large-scale construction operations. Over 10,000 persons and seven million dollar's worth of equipment are employed directly on the work—the greatest concentration of construction force and plant since the Panama Canal. Operations are at a peak this season. Dam, spillway, and tunnels are scenes of intense activity. The story of the current year's work will be published in a series of five articles, the first of which appears in this issue.

That Ideals May Live

EXPRESSING IN CLEAR LANGUAGE a long-existing professional need, Daniel W. Mead in the presidential address to the American Society of Civil Engineers last week sounded a call for a code of ethics applicable to *all* civil engineers, not only to those engaged in private practice. The call is timely; the problems of ethical relationship that arise in the work of the staff engineer in public and industrial service have too long been ignored. In the days when most civil engineers were independent practitioners a consulting engineers' code was adequate, but today it is more ornamental than useful. The ideals of professional truth and integrity, of guidance by fact rather than by opinion or prejudice, of fair dealing and of constructive human relations, have more weight in staff service than elsewhere. When the staff engineer violates the high trust imposed on him by his professional status, when he subordinates his talents and training to political or other opportunism, when he willingly adapts himself to sweatshop systems, he does more harm to his own and the community's welfare than the consulting engineer can do through overzealous competition or meretricious reports. Therefore, difficult though it may be to translate the principles of rectitude and of duty into terms fitting the work of staff designer or constructor, the attempt ought to be made, so that, in Prof. Mead's words, right ideals "shall predominate in all the relations of our great profession."

A Call to Service

FROM THE RICH BACKGROUND acquired in more than a half-century of active participation in the crusade against one of our most formidable insect pests, the mosquito, Dr. L. O. Howard has prepared a stirring introduction to the series of articles on mosquito control which begins in this issue. For many years until his retirement in 1931, Dr. Howard was chief and then principal entomologist of the U. S. Bureau of Entomology, and his numerous practical contributions to the advancement of scientific knowledge have brought international renown. Not the least of these splendid accomplishments was his research on the life history of *Anopheles* mosquitoes which revealed their vulnerability in the larval stage to adulterated arsenical powders; this discovery led to the adoption of "dusting" marshes and stagnant waters with paris-green and similar larvicides, a procedure which is universally recognized as a standard method of controlling malaria mosquito breeding. In his terse recital of events and personalities Dr. Howard makes frequent mention of the rôle played by members of the engineering profession in furthering anti-mosquito measures. But, in paying this tribute, he goes a step farther and clearly infers that continued progress in the eradication of mosquitoes, with consequent curtailment of disease and other economic losses, is as much a responsibility of the engineer as that of medical and other scientific workers. It is in support of this view that the series of articles on mosquito control beginning in this issue is presented. It is hoped that it will serve as a challenge to the profession.

Basic Policies

ARE TECHNICAL PROBLEMS the engineer's chief or only concern? This question is implicit in all the recent discussions of whether and how his horizon shall be broadened. The actual fact, of course, is that the engineer's planning work, while it precedes actual construction, is itself preceded by and dependent upon the determination of basic policies, which latter often are fixed by broad social and economic considerations to which engineering methods of factfinding and analysis have not yet been applied. The timely discussion of reclamation as part of a national land-use program presented by John W. Haw before the Portland meeting of the Civil Engineers made it evident that broad policy determination is the first question in this field. Reclamation has long been an outstanding subject of civil engineering activity, but there is danger that it will be discontinued or curtailed because of opposition based on prejudiced agricultural arguments and on preconceived notions about land development. Thus, important civil engineering interests may be affected by decisions shaped by nonengineering opinion and not based on factual study. If only in self-defense, the engineer must concern himself with policy questions of this type. In final analysis they should prove amenable to study by engineering methods; but in any case they will require a broader interest and understanding than is now common among men trained to think only in terms of conventional technical problems.

Timely Improvement

QUITE AS WAS FOUND necessary in the case of the Boston Post Road bridge at Bridgeport, whose reconstruction was described in the July 9 issue, strengthening and modernization of decks is needed in many bridges that have been in service for 15 years or more. Most of the older floor types are heavy, short-lived, rough, and not capable of carrying large wheel-load concentrations, and all these defects become evident in accentuated form as traffic increases in volume, speed and weight. Floors are rather behind other bridge elements in their development; the smooth, durable floor that at the same time is

light in weight is still a rarity. Short-span fixed bridges, including the majority of ordinary highway structures, do not particularly need floors of light weight, but bascules and all long-span bridges are heavily penalized by unnecessary weight of floor. The bascule, with its costly counterweighting, offers an obvious place for saving in floor weight, and in the case of long-span, fixed bridges it should be noted that every 10 lb. per sq.ft. of floor weight that can be saved will increase the load carrying capacity of the structure by more than a ton per traffic unit. Such gains fully justify the active efforts put forth in recent years to devise light, rigid and durable floors. The various forms so far brought out, among them the steel channel, open mesh, flat plate and concrete-filled grid types, may be capable of further development; floor constructions are entitled to fully as much of the designer's ingenuity and skill as trusses and bracing. But whether or not they will be further advanced, the adoption of modern floor types and modernization of old floors is important to the improvement of highway bridge practice.

Making the Earth Firm

NOVEL METHODS of compacting road fills and foundations for fills are described in the group of abstracts of soil mechanics papers published in this issue. In their present state of experimentation these methods do not permit of entirely positive conclusions but they point directly to considerations that the roadbuilder cannot much longer disregard. Common practices of dumped road fill are not a credit to the roadbuilding art; engineering calls for some better resort than waiting for time to compact embankments before a lasting pavement can be put on them.

In building the German express roads permanent surfacing could not wait on fill settlement and fills had to be built that would not settle; therefore, soil compaction was made a serious study. The results as told on another page were a striking development in equipment invention and compacting processes out of which has come wider knowledge of possibilities and limitations in sand-fill stabilization. Somewhat the same urge of necessity confronted the California road engineers in their study to stabilize quickly mud foundations for highway embankments, and again knowledge was definitely advanced.

These examples in a limited field show clearly that possibilities and practices in compacting and hardening earth for engineering purposes are rapidly widening their horizons of practical use. In the proceedings of the Soils Conference held last month at Harvard University practical use was recorded of half a score of methods ranging from compaction of earth embankments and road foundations to the solidification of deep earth layers in and on which engineering works have to be carried out.

Neither the idea of compaction by pressure and impact or that of solidification by impregnation is new; instead both are very old in modern construction practice. The new thing is that increased knowledge of soil action and constitution is making our hand more sure in bringing about the hardening process. By this knowledge we compose our soils more perfectly for compaction and we can choose exactly from a wide range of hardening substances the one that the soil is fitted best to receive for solidification.

The old term "grouting" no longer comprehends the whole meaning of earth solidification by introducing hardening media. Nor does rolling exhaust the means of mechanical compaction. It is still a long road to complete control of the hardness of the earth for engineering purposes but also something can be done and many experimenters are making the processes more certain as opportunity for field tests comes.

Waterworks Recruits

IN a thought-provoking discussion before a recent section meeting of the American Water Works Association the problem of recruiting well-trained young men for waterworks engineering was brought into the limelight. It was shown that the colleges have much trouble in placing their graduates in this field, and that students who would like to enter the water service industry do not find it easy to obtain positions comparable with those of their classmates who go into the service of manufacturing industry. The discussion brought out also that the waterworks field offers all needed incentives to the engineering beginner, except the important one of giving him assurance of a satisfactory and stable living. And overcrowding of the field is not a problem. The difficulties of placement, then, must lie in causes other than the number of vacancies to be filled or lack of attractiveness of the waterworks career. There are reasons for thinking that both the industry itself and the technical societies are partly to blame.

It has long been the practice for important industries, through the larger companies comprising them, to draw to themselves the best available graduates of each year's class by sending recruiting agents to the schools in the spring. Waterworks officials, on the other hand, have never done such recruiting and are not now doing it. As a result, many capable and well-trained young men who are about to take their degrees in waterworks engineering and who are filled with enthusiasm for water service are likely to go into other fields of activity. The waterworks industry will lose in consequence; but if so it will have mainly itself to blame.

The profession also bears some responsibility. While the general engineering societies through their student chapters are active in attracting recruits to the profession and in leading them into constructive contacts, the waterworks societies do nothing of the kind. The young graduate is left to drift into whatever position he can find, and the educator has only casual contact with the waterworks officials who control technical employment. One result of this situation has been that sanitary engineering courses in many schools are declining and that enthusiasm and interest for the courses are visibly decreasing. A secondary effect is that the training cost per graduate is far greater for the water student than for others. As concerns the waterworks organization itself, political recruiting and the selection of less qualified material for the service are encouraged. The water consumer pays in the end—and incidentally the industry as well as the public suffers. Progress in performance, in administration, in finance and in operation cannot keep pace with progress in other industries.

To better this situation the first and most obvious step is action on the part of waterworks engineering societies. Any movement on their part to bring better contact between educators, students of water engineering and waterworks officials will be of direct value.

CURRENT NEWS

Texas Flood

Tail of hurricane over Guadalupe valley results in worst flood on record for that part of Texas

ONE of the most disastrous floods in the history of the middle and lower sections of the Guadalupe River basin in Texas occurred during the first few days of July 1936. Twenty-six lives were lost and damages to crops, highways, railroads, bridges, livestock, dwellings and merchandise will total many millions of dollars. The *San Antonio Express* of July 7 carries a statement of probable losses in four counties as estimated by a committee of facts, appointed by S. M. Ainsworth, mayor of Gonzales, as follows: "Gonzales County $2,530,000; DeWitt (Cuero) $4,000,000; Caldwell (Luling-Lockhart) $465,000; Victoria $5,995,000." A total of $12,990,000. Heavy losses occurred in many other counties, but no estimates are available at this time.

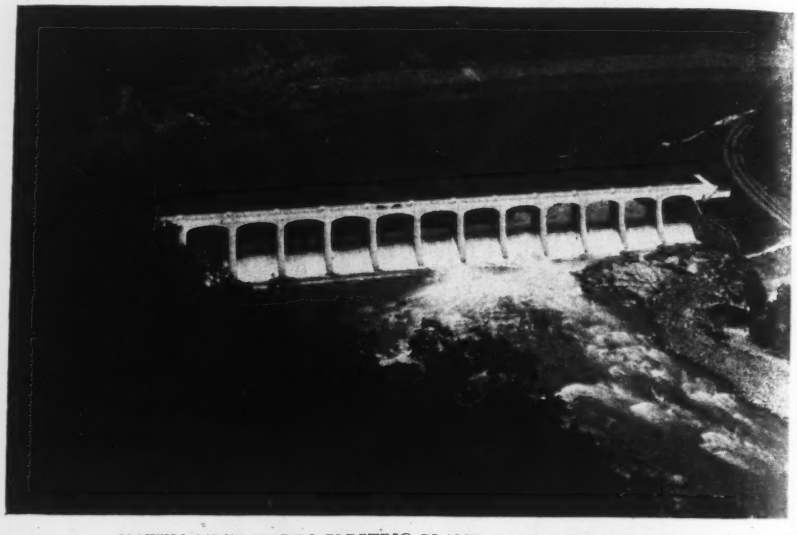
Rrainfall up to twenty inches

Below New Braunfels where the Guadalupe River leaves the rugged Edwards plateau region and enters the coastal plains area, the rainfall varied from about 5 in. to possibly as much as 20 in., most of which fell in a few hours during the night of June 30 and early morning of July 1. From information now available, it appears that the heaviest rain was in the western part of Gonzales County. At Leesville, near the head of Sandies Creek, it is reported that at least 20 in. fell during the storm and most of that amount within a period of 12 hours. J. H. Jarboe, meteorologist of the San Antonio office, U. S. Weather Bureau, stated that the heavy rainfall resulted from the breaking up of a hurricane of moderate intensity that originated in the Gulf of Mexico near the Texas coast and passed inland in the vicinity of Corpus Christi on June 27. Heavy rains occurred over the Nueces River basin and in the vicinity of Eagle Pass and Del Rio between the time the hurricane left the Gulf and the time of the beginning of heavy rainfall on June 30 in the Guadalupe basin. Considerable damage was caused by floods in the vicinity of Eagle Pass, and on the Nueces, Frio, San Antonio, Medina and Colorado rivers and various other streams in central and southern Texas; but it was only in the Guadalupe River basin that the floods reached record-breaking proportions.

The discharge of the Guadalupe River above the mouth of the Comla River at New Braunfels amounted to 19 sec.-ft. per sq.mi. from a drainage area of 1,666 sq.mi.

Records being collected

The U. S. Geological Survey now has parties in the field collecting unofficial rainfall records and determining peak discharges at various points in the storm area. A special report of the stages and discharges of these floods will be prepared by the survey as soon as the field data can be collected and analyzed.



HAWKS NEST HYDRO-ELECTRIC PLANT GOES INTO SERVICE

The Hawks Nest hydro-electric plant of the Electro Metallurgical Co., on the New River in West Virginia, was put into service on July 9. Equipped with four 35,000-hp. turbines, the plant has a total capacity at present of 120,000 hp. Space has been provided for a fifth unit if it is ever needed. The entire output of the plant goes to the company's industrial works at Alloy, W. Va., supplementing a 60,000-hp. steam plant built in 1934.

The accompanying view shows the diversion dam in New River gorge, three miles above the power plant. The dam, 836 ft. long, creates no storage, as the plant operates on run of the river only. Connecting the dam and the power plant is a pressure tunnel 16,250 ft. long, unusual in that about two-thirds of its length is unlined. Lined sections are 31 ft. and 32 ft. in diameter; unlined portions vary from 42 ft. to 46 ft. in size. The tunnel was driven from both portals and from an adit about midpoint. A reservoir at the mouth of the adit will serve as an auxiliary surge basin. The main surge tank is a steel structure 116 ft. in diameter and 56 ft. high, of the differential type, located at the lower portal.

Taking off from the outlet portal is a 30-ft. welded steel penstock, with branches reducing to 14 ft. in diameter for each of the five units. The plant operates under a head of 163 ft.

Housing Work May be Done on Force Account

Faced with continued difficulty in obtaining satisfactory bids on P.W.A. housing projects, Administrator Ickes said, July 21, that: "We may do housing by force account."

No bids were received this week on the advertisement for a Birmingham project, and four bids received for building Andrew Jackson Court in Nashville were rejected as excessive. This follows rejection of bids on projects in Philadelphia, Wayne, Pa., and Louisville. Ickes asserted that the objectives of the slum clearance program could not be achieved if contractors bid in such a manner as to defeat its low rent aspect.

New York and Cincinnati have submitted proposals for undertaking housing projects with a 45 per cent grant from the new money available to P.W.A. for non-federal public works projects. New York has three projects, totaling about $15,000,000. It is still doubtful, however, whether any housing projects will materialize on this basis.

Walsh-Healey Bill Enforcement

Washington Correspondence

SECRETARY of Labor Perkins stated on July 17 that the Labor Department still is studying the Walsh-Healey government contract act and will shortly make an announcement outlining its enforcement. A meeting of industrial leaders was called by the Secretary on July 16 for the purpose of discovering the chief problems expected to arise in enforcing the act. No attempt was made to obtain full representation of all industries; attendance was determined principally by ability to be present on short notice.

The Secretary stated flatly that she does not interpret the act as applying to public works construction.

The act places full authority for its administration in the Secretary of Labor. Miss Perkins believes that in drawing up regulations, and particularly in making exemptions, power should not be concentrated too closely. Therefore, as an administrative measure, she intends

appoint a board of three to advise her on these points.

One of the questions brought up at the July 17 meeting was the responsibility of the principal contractor for acts beyond his control, such as by sub-contractors. The act does not clearly apply to sub-contractors except the clause relating to safety, health and inspection laws of the states. Miss Perkins believes it will be necessary to define very definitely what responsibility will devolve upon the principal contractor.

The effects of the act on government contracts and on industry generally will be watched very closely by the department, which expects to learn a great deal from its experience and will modify enforcement where necessary.

In response to a question, the Secretary said that no figures are available showing how many workers will be effected by the act.

Louisiana Sets Up Planning Board

Board will draft master plan for development of the state and will pass on all public construction

THE LOUISIANA State Planning Commission was established at the last session of the legislature. The commission will consist of seven members, six of whom are ex-officio members: The chairman of the Louisiana highway commission; the commissioner of conservation; the chief of the state board of engineers; the president of the state board of health; the commissioner of agriculture and immigration; a member of the agricultural and mechanical college, Louisiana State University. The seventh member, the chairman, will be appointed by the Governor, will be paid, and will serve for three years. The commission may appoint an executive director and secretary, "who shall be qualified by special training and experience in the field of city, county, regional or state planning," and may employ planners and other consultants for services as required.

Duties of commission

The duty of the commission will be to formulate a master plan for the physical development of the state. The plan will cover such subjects as highways, waterways, waterfront developments, flood protection work, parks, forests, wild life refuges, aviation fields, drainage and sanitary work, power transmission facilities, public buildings, and other public works or public utility facilities within the jurisdiction of state bodies. Also included is the development of a comprehensive land utilization program, including the classification and allocation of land within the state among agricultural, forest, recreational, soil conservation, industrial, urban and other uses.

The commission is empowered to obtain needed information from any public official and may request the Governor to have special studies or surveys made by any public agency.

After a plan has been established, all publicly financed construction will be required to have the approval of the planning commission.

Vindication for Willacy Defendants

The board of directors of the American Society of Civil Engineers, at its recent meeting, expressed its confidence in Charles R. Olberg and Perry A. Welty, who were acquitted of charges arising out of the Willacy County, Texas, irrigation project (ENR, April 23, 1936, p. 610). The other defendants, who were acquitted, were: William A. Harding, Frank P. McElwrath, James P. Barry, Leonard C. Hammond, and Harry W. Cole. None of the latter is a member of the society.

Detroit Engineers Give Vocational Guidance

One hundred and twenty-three high school students contemplating the study of engineering attended the first annual guidance meeting of the Associated Technical Societies of Detroit. The conference was held at the suggestion of the committee on student selection and guidance of the Engineers Council for Professional Development, and was typical of guidance meetings which E.C.P.D. is promoting in other areas through local associations of engineers.

The meeting opened with a general gathering at which the purpose and plan of the meeting was explained and a talk was given which distinguished between the various fields of engineering. The meeting was then broken up into a number of groups representing the different fields of engineering. In these groups a seminar plan of discussion was followed. Finally, private interviews, where desired, were held between councilors and students.

Association Continues Study Begun by Railway Coordinator

The Association of American Railroads will continue the studies of railroad operations which were carried on by the Federal Coordinator of Transportation, Joseph B. Eastman, and the regional coordinating committees of railroad executives under the Emergency Transportation Act, which expired on June 17. Studies of economies through coordination were inaugurated by railroad committees in the Eastern, Western, and Southern regions prior to the enactment of the coordinator law. After the passage of that act in 1933, Coordinator Eastman continued these studies through regional coordinating committees of railroad executives set up under the law and also inaugurated a series of studies covering the general field of railroad operations.

In order to continue these studies; the board of directors of the association has requested the railroads in each of the three regions to select an appropriate committee to carry on the study of projects already under consideration and such other projects as may be presented. These committees will report to the president of the association, who will take up with the individual railroads involved the matter of accomplishing the economies which may be indicated.

Study of recommendations already made by the Federal Coordinator, with a view to effecting the economies indicated, will be continued.

Drought

Drought continues unbroken—no general water shortage, but local deficiencies in some places

THE DROUGHT continued unbroken this week, as scattered showers over large areas were entirely inadequate to alleviate conditions steadily becoming more critical. Rain fell in southern Iowa, southern Wisconsin, and the eastern Gulf and South Atlantic districts, but, except for showers in North Dakota, there was little or no precipitation in the Great Plains.

Lower temperatures brought relief from the heat east of the Mississippi River and in the western Lake region, but there were no general rains. Extreme heat still prevailed between the Mississippi River and the Rocky Mountains, with new records in Kansas and Oklahoma. A new hot spot developed covering Nevada, northern Utah, Idaho, eastern Oregon, and eastern Washington, while unfavorable conditions in the central and southern plains were greatly intensified by continued absence of rain and abnormally high temperatures.

No general shortage of public water supplies in the drought stricken region is anticipated by the Geological Survey. Some localities, however, are feeling the pinch of curtailed domestic supply; this will become serious in many sections unless substantial rains occur.

Additional reports received by the Geological Survey from its district engineers since the reports published in *Engineering News-Record* July 16 cover the following states:

Nebraska

Ground water level in Nebraska is now lower than in 1934. This affects the water supplies for municipal purposes, as most towns and cities in the state depend upon wells. Stream flow is about the same as during 1934. In irrigated districts in the western part of the state surface supplies also are short. On the North Platte River, canals having decrees subsequent to October, 1889, are now dry. In 1934 the date of the decrees affected was December, 1889. Very little rain has fallen since early in June.

Wyoming

Water supplies generally throughout Wyoming for municipal, industrial and farm use are reported to be very low and are about the same as in 1934 at this time of year. In thirteen counties in northeastern Wyoming the shortage is considerably more serious than in other sections of the state. Very little rain has fallen since early Spring, and, with recent high temperatures, the situation is critical. The flow of streams on the plains in northwestern Wyoming during June was about 25 per cent less than in June, 1934. The flow of streams from the mountain regions was about the same as in 1934.

Montana and Western North Dakota

Shortage of water supplies is reported to be very serious in eastern Montana and western North Dakota. The most severe situation prevails in the area surrounding Miles City, Montana, and extends eastward to Bismarck, N. D. Up

to July 11, however, no reports had been received of critical shortages for industrial or municipal purposes. There is a decided shortage of supplies for domestic farm use in these areas. Practically no water is available for irrigation, as the spring run off was very small and very little water was held in storage. Farm wells have been depleted in many localities, making it necessary to haul domestic water considerable distances.

Oklahoma and Arkansas

In Oklahoma and Arkansas streams seem to be holding their own, and the flow is greater than in 1934. Springs are falling off, and well levels generally are lower than last year, although the situation generally is not as bad. The deficiency in rainfall now ranges from 8 to 15 inches short of the normal since the first of the year.

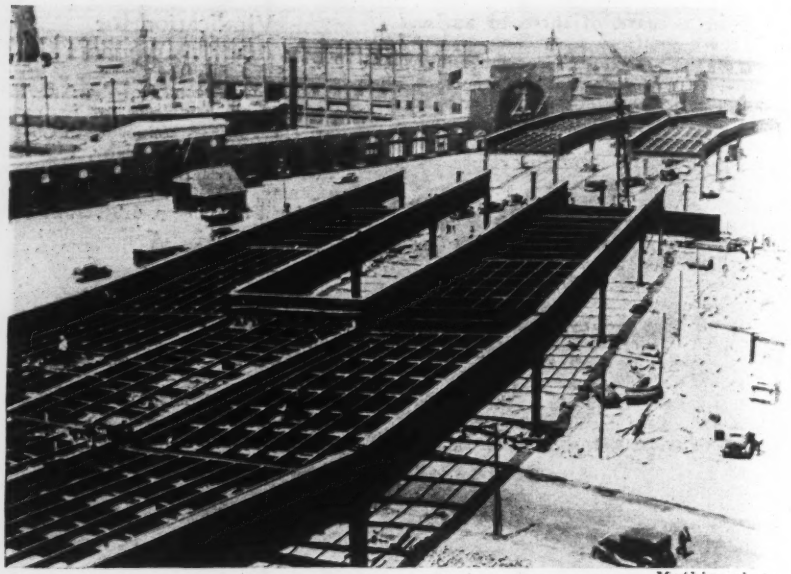
Washington Highlights

By Paul Wooton

The President stated at a recent conference that work on the shelter belt would go forward. This is interpreted to mean, however, that only a limited amount of tree planting will be done with work relief funds.

A shakeup has been ordered in the PWA by Secretary Ickes preliminary to the new public works program. One of the principal changes will take the PWA out from under the division of investigation, until recently headed by Louis R. Glavis whose espionage system had such a bad effect on PWA morale. A new PWA investigation division has been created under Angelo Clas who will become an assistant administrator and will have charge of all PWA investigations with special reference to construction methods and practices. Howard A. Gray, PWA inspector for two years, has been made director of the housing division, the position vacated by Clas. Jabez G. Holston, director of the PWA engineering division, has been made director of the inspection division, and Arthur J. Bulger has been advanced to director of the engineering division.

Chances of starting any important work under the Omnibus Flood Control Act are slim. Some small projects may be started with relief funds but nothing of moment is expected on the larger and more important projects until actual appropriations are made by Congress. The measure approved at this session was an authorization bill only. No money was appropriated. The Overton Act covering flood control on the lower Mississippi also is an authorization bill only, but in that case an appropriation of $15,000,000 was carried in the War Department Appropriation bill. This money was appropriated, prior to the passage of the Overton bill, out of the remaining authorization of the Flood Control Act of May 15, 1928. After that appropriation was deducted there remained $52,000,000 of the old authorization, but this remaining authorization is wiped out by the new authorization of $272,000,000 carried by the Overton Act. This $272,000,000 is regarded as sufficient authorization to complete the project.



Mathieu photo

ERECTION OF THE STEEL superstructure of the last section of the West Side elevated highway, New York City, between 46th and 59th Streets. Completion of this section in the fall will provide an express highway from the Holland Tunnel to 72nd Street, about four miles. The above photograph was taken looking north from 54th Street.

Coordinating Flood Control Work

Gov't agencies meet to coordinate the various objectives sought—work will be started with relief funds

WITH a view to getting flood control work under way by August, principally in New York, Pennsylvania and Ohio, the Water Resources Committee of the National Resources Committee met on July 21, with representatives of the U. S. Flood Control Federation and with other federal agencies to develop a procedure on emergency projects provided for in the Omnibus flood control act of 1936.

The intention of the Water Resources Committee is to develop methods by which flood control activity may go ahead while collateral objectives of other agencies of the government in emergency flood control areas, such as conservation, reforestation, etc., proceed as expeditiously as possible. The committee reported that it had already taken up with the Soil Conservation Service, the National Forest Service, the Biological Survey, the U. S. Geological Survey, the Federal Power Commission, the Bureau of Reclamation, the W. P. A., and the C.C.C. the necessity of submitting at once any plans they may have which might be involved in the contemplated work. Such plans are to be submitted within five days.

The federal officials and representatives of the Federation were in agreement as to the objectives. It was made clear that no appropriation was available under the flood control act of 1936, but that work could be undertaken with funds made available from the relief and C.C.C. appropriations. (This is still an open question, according to Secretary Ickes.) Relief and C.C.C. workers would be utilized wherever possible. Arrangements were made to expedite local and state planning, which must precede actual construction.

Public Works Act Claimed Unconstitutional

The question of the constitutionality of the public works section of the National Industrial Recovery Act is raised, for the first time, in a suit entered in the United States Supreme Court by the Potomac Electric Power Co. of Washington.

The suit originated as a routine land condemnation when the government, through the procurement division of the Treasury, condemned a small plot of land, on which the power company had a substation, for the site of the new Interior Building. Although the company claimed a loss of $180,000, the district court awarded it only $23,167; this verdict was subsequently upheld by the court of appeals, and is now being carried to the U. S. Supreme Court on the constitutionality issue.

Low Water in the Upper Mississippi

Although spring floods bring cumulative flow-figures to normal, present flow is less than one-third of normal

WITH rainfall only about one-half that of normal and present river flow less than one-third of normal, 1936 may be a year of record low water for the Upper Mississippi River.

On July 17 the flow of the Mississippi at Rock Island, Ill., was slightly over 16,000 sec.-ft.; the normal flow for that day, based on a 60-year average from 1874 to 1934, is 60,000 sec.-ft. At Dubuque, Iowa, the stage of the river on July 17 was nearly 6 ft. below normal; the normal figure here used excludes figures for 1934, which were the lowest stages ever recorded.

In a normal year 50 per cent of the year's precipitation in the Mississippi watershed

above Rock Island has occurred by July 1; 59 per cent of the total year's runoff normally occurs before that date. This year only 28.5 per cent of a normal year's precipitation has occurred, as compared with 27.0 per cent in 1934. However, 55.5 per cent of the normal yearly runoff has occurred, while in 1934 only 23.5 per cent of a normal year's runoff had been recorded on July 1. Heavy snows melting early this spring explains the nearly normal total runoff recorded to date in contrast to the small amount of precipitation received.

About 18 in. of precipitation is generally received at Rock Island by the middle of July, while this year only a little more than 9 in. has been received.

With the period of lowest stages ordinarily not occurring until five or six weeks after the middle of July, much lower readings may occur this year.

Four of the last five years have been exceptionally dry ones for the Upper Mississippi Valley. Stages lower than those of 1864 did not occur generally until 1931. That year was followed by exceedingly low stages in 1932, 1933, and 1934. Lowest stages on record were recorded during 1934.

At present the minimum navigable channel depth below the Twin Cities is near 5½ ft. The canalization program for the Upper Mississippi, a development calling for 26 low-head dams between St. Louis and Minneapolis, is now, roughly, 65 per cent complete. When finished in 1939, at a cost of $150,000,000, the project will supply a minimum navigable channel depth of 9 ft. throughout the navigation season, regardless of the amount of flow.

SOCIETY CALENDAR

ILLUMINATING ENGINEERING SOCIETY, annual convention, Buffalo, N. Y., Aug. 31 to Sept. 3.

CANADIAN GOOD ROADS ASSOCIATION, annual meeting, Charlottetown, P.E.I., September 1-3.

PUBLIC WORKS CONGRESS, joint meeting, AMERICAN SOCIETY OF MUNICIPAL ENGINEERS AND INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Toronto, Ont., September 28-30.

CANADIAN INSTITUTE OF SEWAGE AND SANITATION, Royal York Hotel, Toronto, Oct. 1-2, 1936.

AMERICAN WATER WORKS ASSOCIATION, CENTRAL STATES SECTION, Cleveland, Ohio, Aug. 19-21.

ENGINEERING INSTITUTE OF CANADA, maritime general professional meeting, St. Johns, N. B., Aug. 27-29.

AMERICAN WATER WORKS ASSOCIATION, ROCKY MOUNTAIN SECTION, Denver, Colo., Sept. 21-23.

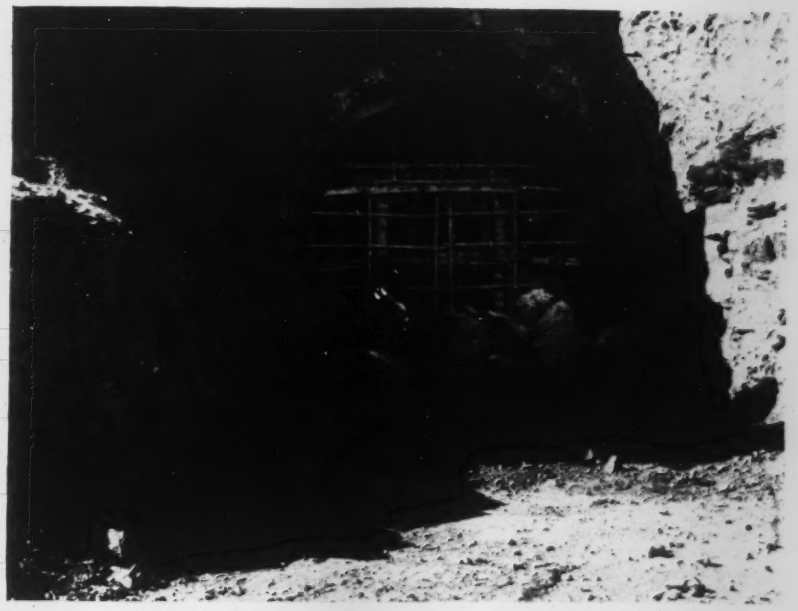
NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, New York, N. Y., Sept. 22-25.

AMERICAN WATER WORKS ASSOCIATION, NEW YORK SECTION, fall meeting, Saratoga Springs, N. Y., Oct. 22-23, 1936.

TENNESSEE ROAD BUILDERS ASSOCIATION, at its annual convention, July 10, elected the following officers: president, Wade B. Moore, of Dyersburg; first vice-president, W. L. Stacy, Johnson City; second vice-president, J. E. Thomas, Nashville; third vice-president, M. N. Leventhal, Chattanooga; secretary-treasurer, T. M. Strider, Nashville; directors, F. V. Geigler and A. M. Wessmer, of Nashville; engineer-manager, J. M. Farrar, Nashville.

EXAMINATIONS for registration as Engineers, Land Surveyors and Architects will be held as follows:

NEW MEXICO, examination for professional engineers and land surveyors, Santa Fe, Sept. 12.



HOLING THROUGH diversion tunnel No. 1 at Parker dam on the Colorado River. The Colorado River will be diverted through this and another tunnel while the dam is under construction. Parker dam is 155 miles below Boulder Dam and will serve chiefly to form the reservoir from which the Metropolitan Water District of Southern California will pump water into the Colorado River aqueduct. Power also will be developed at the dam.

Personals

LUTHER M. KEITH, director of the bureau of roadside development in the Connecticut state highway department since 1927, has resigned. JOHN L. WRIGHT, assistant director, has been appointed acting director.

MAJOR CARL SHAW has been named military assistant to the U. S. District Engineer at Memphis, Tenn.

LT.-COMMDR. JOHN A. SCOVILLE, C.E.C., U.S.N., formerly at the naval station, Guantanamo Bay, Cuba, has been assigned to duty at the navy yard, Philadelphia, Pa.

JOHN H. HUBER, formerly engineer of bridges and grade crossings and assistant first deputy commissioner of highways, New York State Department of Public Works, is now associated with the Robinson Clay Products Co., of New York City.

E. N. SHOWALTER, senior engineer with the Federal Power Commission, has been assigned to their regional office at Atlanta, Ga. Mr. Showalter has been with the commission for several years and was previously connected with the Trojan Engineering Co. of New York.

SAMUEL SHULITS has been appointed assistant professor of mechanics and hydraulics at the Colorado School of Mines. Since 1933, Mr. Shulits has been with the United States Bureau of Reclamation as specialist on the Colorado River silt problem.

SOLON HERZIG has been appointed resident engineer inspector for the PWA on the construction of a tuberculosis sanitarium near Orlando, Fla. Previously Mr. Herzig was resident engineer inspector on the Jackson Memorial Hospital at Miami, Fla.

CAPT. HUGH CASEY, chief of the engineering division of the Passamaquoddy Bay tidal power project, has been transferred to the Boston district office of the U. S. Engineers.

W. H. HAY, member of the Los Angeles, Calif., Board of Water and Power Commissioners for the past year, has resigned. He was appointed to the board to succeed the late A. B. Prior.

CYRUS B. BABB has been appointed associate water consultant for the third drainage district of the National Resources Committee.

Obituary

CHARLES HEIGEMANN, 74, a Denver contractor, died on July 11.

JOSEPH PINCHBECK, a retired contractor of New York City, died in Albany on July 16 at the age of 91.

ALVIN LEVAN, city building inspector at Santa Monica, Cal., since 1932, died July 13 at the age of 61.

BENJAMIN F. HASKELL, a highway contractor in Rhode Island, died at Central Falls, R. I., on July 15 at the age of 65.

HARVEY HARRINGTON, 73, a retired civil engineer of New York City, died in Rangeley, Maine, on July 17. Mr. Harrington was a graduate of the Sheffield Scientific School. He spent some years in engineering work for the New York Central R.R. and later for the dock department of the city of New York.

RANDOLPH MAURY BROWNE, 48, an architect of Norfolk, Va., and a member of the firm of Browne & Fitzgibbon, died July 14 in Norfolk.

EDWARD D. SABINE, 62, prior to his retirement in 1926 an assistant engineer for the New York Central R.R., died in New York City on July 16. Mr. Sabine, a graduate of Tufts College engineering school, has been connected with the New York Central R.R. since 1905. He was in charge for some years of work in connection with building the present Grand Central Terminal and served as terminal engineer there from 1913 to 1916.

GEORGE DUNNER, an architect of Hartford, Conn., and formerly a member of the Hartford Building Commission, died July 13 in Mount Clemens, Mich., at the age of 75.

ELDORUS CHESTER SLADE, a retired contractor of Fall River, Mass., died in North Somerset, Mass., on July 18, at the age of 78.

ALBERT B. MAUPIN, for 25 years city engineer of Huntington, W. Va., died there July 16, at the age of 73. Mr. Maupin had retired in 1931.

WILLIAM H. LARKIN, Jr., 65, a c[illegible]ing engineer of Boston, died in Arli[illegible], Mass., on July 16. In recent years Mr. Larkin was connected with the U[illegible] States Rubber Co. as division power and safety engineer with jurisdiction over various plants in this country and Canada.

WILLIAM J. APPLEGATE, for many years a building contractor in New York City, died there on July 19, at the age of 7[illegible].

WILLIAM J. WHITE, 76, a civil eng[illegible]er of Buffalo, N. Y., and a member of the firm of White & Getman of that city, died there on July 19.

CONSTRUCTION STATISTICS FOR THE WEEK

HIGH PRIVATE and federal awards raise this week's total for engineering construction to $50,992,000, compared with $42,689,000 last week and with $43,780,000 for the average week to date this year. This total is made up of private awards, $17,169,000, and public, $33,823,000, of which federal is $16,895,000 and state and municipal, $16,928,000. Corresponding values for a year ago are: total, $25,924,000; private, $5,596,000; public, $20,328,000, of which federal was $9,572,000 and state and municipal, $10,756,000.

This week's high figure is due to building awards, commercial, industrial and public. The commercial building total is the highest it has been for any single week in more than three years, due to heavy awards of apartment house buildings in New York City. The totals for the principal classes of construction are: streets and roads, $7,820,000; bridges, $2,960,000; sewerage, $98,000; waterworks, $873,000; earthwork and drainage, $1,388,000; commercial buildings, $9,417,000; industrial buildings, $6,596,000; and public buildings, $19,863,000.

The larger projects for the week include: automobile factory, Studebaker Motors Corp., Los Angeles, Calif., $1,000,000; mill additions for Union Bag & Paper Co., Savannah, Ga., $2,750,000; library, Kansas City, Mo., $810,000; superstructure, Kentfield Housing Project, Buffalo, N. Y., $3,999,000; Old Harbor Village Housing Project, Boston, Mass., $4,980,000; Columbia Terrace, Columbia, S. C., $558,000; Dixie Homes, Memphis, Tenn., $2,329,000; Cheatham Place Housing Project, Nashville, Tenn., $1,521,000; and Lucas Drive Housing Project, Dallas, Tex., $803,000. At Bath, N. Y., the U. S. Veteran's Hospital was let for $798,000. Highway awards include: Georgia, $991,000; Illinois, $773,000; Wisconsin, $1,330,000 and New Jersey, $630,000; bridges, Illinois, $874,000 and North Dakota, $728,000. Among the larger unclassified awards is one for 20,000 tons steel rails by Norfolk & Western Ry., Virginia, estimated at $728,000.

New capital for the week totals $10,435,000, state and municipal bond sales amounted to $6,310,000 and corporate security sales were $4,125,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average July 1935	Prev. 4 Weeks	Week July 23 1936
Federal Government	$3,826	$10,005	$16,895
State and Municipal	12,285	23,468	16,928
Total public	$16,111	$33,473	$33,823
Total private	5,607	13,619	17,169
Week's total	$21,718	$47,092	$50,992

Cumulative to date:
1935...$744,144,000 1936..$1,313,370,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

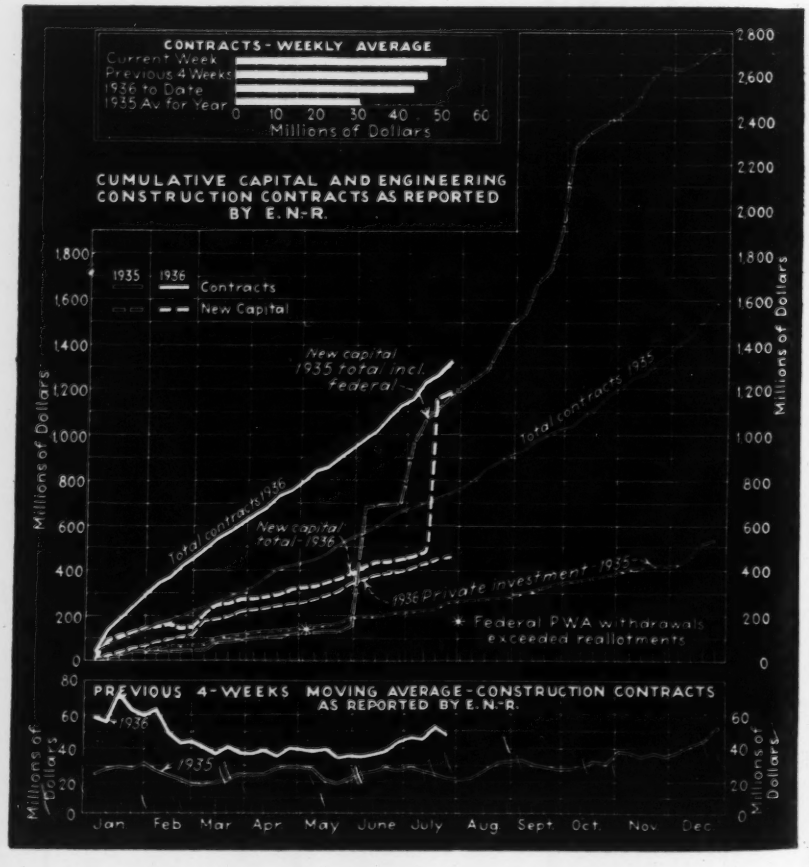
1936	Week July 23	Cumulative
State and municipal	$6,310	$305,677
PWA non-federal	....	32,190
RFC loans	....	12,479
Corporate issues	4,125	146,117
PWA loans, Private	....	*—1,665
Total Non-Federal	$10,435	$494,798
Federal	....	691,237
Total new capital	$10,435	$1,186,035

Cumulative to date:
1935...$1,108,014,000 1936..$1,186,035,000
*Bond sales in this classification exceed reallotments during current year.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for federal construction, deficiency act funds.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
July, 1936	202.60	97.38	June, 1936	196	86
June, 1936	204.60	98.35	May, 1936	149	65
July, 1935	195.18	93.82	June, 1935	122	54
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1935 1936
Contracts
New Capital
New capital 1935 total incl. federal
Total contracts 1935
Total contracts 1936
New capital total 1936
1936 Private investment
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1936
1935
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec